W32 14 $9.95 CDN
SILICON CHIP JUL 14 26/06 1511
NDC 7T
9 771032 66001 07

SILICON CHIP

JULY 2014
ISSN 1030-2662 07
9 771030 266001
PP255003/01272
$9.95* INC GST NZ$12.90 INC GST

Argo:

3,561 drones scouring the world's oceans for climate data

We build:

andy
hreshold
oltage Switch

We review:

Stereo Microscope for SMD PCB Assembly

Latest Eye-Fi mobi SD cards

KITS BUILD THEM!

ONLINE & IN STORE

AUTOMOTIVE KITS

Programmable High Energy Ignition Kit

Ref: Silicon Chip Magazine March/April 2007

This advanced and versatile ignition system can be used on both two & four stroke engines to intercept and modify the factory timing or as the basis for a stand-alone ignition system with variable ignition timing, electronic coil control and anti-knock sensing. Kit includes PCB with overlay, programmed micro, all electronic components, and die cast box.

- PCB: 102 x 81mm

KC-5442

$69.95

Capacitor Discharge Ignition Kit for Motor Bikes

Ref: Silicon Chip Magazine May 2008

Many modern motor bikes use a Capacitor Discharge Ignition (CDI) to improve performance and enhance reliability. However, if the CDI ignition module fails, a replacement can be very expensive. This kit will replace many failed factory units and is suitable for engines that provide a positive capacitor voltage and have a separate trigger coil. Supplied with solder masked PCB and overlay, case and components. Some mounting hardware required.

- PCB: 45 x 64mm

KC-5466

$21.95

CONTROL & AUTOMATION

Tempmaster Fridge Controller Mk II Kit

Ref: Silicon Chip Magazine February 2009

Turn an old chest freezer into an energy-efficient fridge or beer keg fridge. Or convert a standard fridge into a wine cooler. These are just two of the jobs this low-cost and easy-to-build electronic thermostat kit can do without the need to modify internal wiring! Short-form kit contains PCB, sensor and all specified components. You'll need to add your own 240VDC GPO, switched IEC socket and case.

- PCB: 68 x 67mm

KC-5476

$32.95

433MHz Remote Switch Kit

Ref: Silicon Chip Magazine January 2009

Suitable for remote control of practically anything up to a range of 200m. The receiver has momentary or toggle output and the momentary period can be adjusted. Up to five receivers can be used in the same vicinity. Short-form kit contains two PCBs and all specified components.

- Requires case & 9 - 12VDC power
- PCBs: TX: 85 x 63mm RX: 79 x 48mm

KC-5473

Extra transmitter kit: KC-5474 $22.95

$44.95

240V 10A Deluxe Motor Speed Controller Kit

Ref: Silicon Chip Magazine April 2009

The deluxe motor speed controller kit allows the speed of a 240VAC motor to be controlled smoothly from near zero to full speed. The advanced design provides improved speed regulation & low speed operation. Also features soft-start, interferences suppression, fuse protection and overcurrent protection.

- Kit supplied with all parts including pre-cut metal case

KC-5478

$99.95

NOTE: Not for use with induction motors.

DC Relay Switch Kit

Ref: Silicon Chip Magazine November 2006

An extremely useful and versatile kit that enables you to use a tiny trigger current - as low as 400µA at 12VDC to switch up to 30A at 50VDC. It has an isolated input, and is suitable for a variety of triggering options. The kit includes PCB with overlay and all electronic components.

KC-5434

$16.95

Ultrasonic Antifouling Kit for Boats

Ref: Silicon Chip Magazine Sept/Oct 2010

Marine growth electronic antifouling systems can cost thousands. This project uses the same ultrasonic waveforms and virtually identical ultrasonic transducers mounted in sturdy polyurethane housings. Standard unit consists of a control electronic kit and case, pre-built ultrasonic transducer, gluing components and housings. The single transducer design of this kit is suitable for boats up to 10m (32ft); boats longer than about 14m will need two transducers and drivers. Basically all parts are supplied in the project kit including wiring.

- 12VDC
- Suitable for power or sail
- Could be powered by a solar panel/wind generator
- PCB: 104 x 78mm

KC-5498

$249.00 INCLUDES EPOXIES!

Jaycar Electronics

Better, More Technical

Theremin Synthesiser Kit MkII

Ref: Silicon Chip Magazine March 2009

Create your own eerie science fiction sound effects by simply moving your hand near the antenna. Easy to set up and build. Complete kit contains PCB with overlay, pre-machined case and all specified components.

- Requires 12VDC power supply (MP-3147 $17.95)
- PCB: 85 x 145mm

KC-5475

$74.95

Jacob's Ladder High Voltage Display Kit MK2

Ref: Silicon Chip Magazine April 2007

With this kit and the purchase of a 12VDC ignition coil (available from auto stores and parts recyclers), create an awesome rising ladder of noisy sparks that emits the distinct smell of ozone. Kit includes PCB, pre-cut wire/ladder and all electronic components.

- 12VDC automotive ignition coil and case not included
- 12V car battery, 7Ah SLA or >5Amp DC power supply required
- PCB: 170 x 76mm

KC-5445

$42.95 DANGER HIGH VOLTAGE

POWER KITS

1.3V to 22VDC 1A Voltage Regulator Kit

Ref: Silicon Chip Magazine May 2007

Provide up to 1,000mA at any voltage from 1.3 to 22VDC. Ideal for experimental projects or as a mini bench power supply etc. Kit supplied with PCB and all electronic components.

- PCB: 38 x 35mm

KC-5446

$16.95

Improved Low Voltage Adaptor Kit

Ref: Silicon Chip Magazine May 2008

Runs a variety of devices such as CD or MP3 players from your car cigarette lighter socket or even powered speakers from the power supply inside your PC. It will supply either 3V, 5V, 6V, 9V, 12V or 15V and (when used with an appropriate input voltage and heatsink) deliver up to 4A at the selected output voltage.

- Kit includes screen printed PCB and all specified components (heatsink not included)
- PCB: 108 x 37mm

KC-5463

$17.95

Contents

SILICON CHIP

Vol.27, No.7; July 2014 www.siliconchip.com.au

Features

14 Argo: Drones Of The Deep Oceans
Thousands of drones are floating deep in the oceans of the world, monitoring temperatures and other data. They are fully autonomous and can change depth or rise to the surface to send data to satellites – by Dr David Maddison

22 Review: AmScope Stereo Microscope
Even people with 20/20 eyesight have difficulty soldering fine-pitch SMDs to PCBs. This stereo microscope is made for the task and it even has a camera eyepiece to record your work – by Andrew Levido

36 Eye-Fi Mobi SD Wireless Camera Cards
Eye-Fi have gone mobile with their new range of "Mobi" camera SD cards. Now you can very easily send your pictures to any Android or iOS tablet or phone and share them with friends! – by Ross Tester

Projects To Build

26 Threshold Voltage Switch
This versatile unit switches a relay when an input voltage crosses a preset threshold. Use it to switch power to a fan, warning light or similar or use it to prevent a lead-acid battery from being over-charged – by John Clarke

60 Micromite, Pt.3: Build An ASCII Video Display Terminal
It's VT100-compatible and lets you add a video display, keyboard and USB to your next microcontroller project. It's the perfect companion for microcontrollers with serial input/output such as the Micromite and PICAXE– by Geoff Graham

70 Touch-Screen Digital Audio Recorder, Pt.2
Second article gives the assembly details, provides some performance graphs and describes how it's used – by Andrew Levido

80 L-o-o-o-n-g Gating Times For The 12-Digit Counter
This module enables even higher resolution measurements with our 12-Digit Frequency/Period Counter. It adds a decade divider for the external timebase input to allow measurements using a gating time of 10,000s – by Jim Rowe

Special Columns

40 Serviceman's Log
Oh goodie, a valve radio to fix – by Dave Thompson

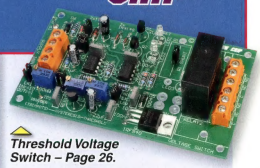
57 Salvage It! Wrecking The Computer Itself
Once you've pulled the main stuff out of your old PC, what do you do with the rest? Don't bin it yet: there's still lots of goodies waiting to be recycled – by Bruce Pierson

87 Circuit Notebook
(1) Signal Injector & Tracer Uses TDA2822M Dual Power Amplifier; (2) Headlight Circuit For A 36V Electric Bike; (3) RS-232 Input For Non-Standard Signals; (4) Simple DIY Gizmos For SMD Desoldering

92 Vintage Radio
The upmarket 1950 HMV R53A radiogram – by Rodney Champness

Departments

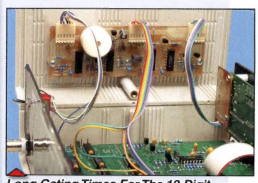
2 Publisher's Letter
4 Mailbag
47 Subscriptions
48 Product Showcase
90 Online Shop
98 Ask Silicon Chip
103 Market Centre
104 Notes & Errata



Threshold Voltage Switch – Page 26.

ASCII Video Terminal With VGA, Composite Video, USB Port & PS/2 Keyboard Input – Page 60.

Building The Touch-Screen Digital Audio Recorder – Page 70.



Long Gating Times For The 12-Digit High-Resolution Counter – Page 80.

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan
Dave Thompson

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $105.00 per year in Australia. For overseas rates, see our website or the subscriptions page in this issue.

Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

Argo drones gathering deep sea data

This month, we have a most intriguing story, written by Dr David Maddison. Did you know that there are thousands of drones drifting deep in all the world's oceans, quietly gathering temperature and other data?

Most people are aware of airborne drones and their amazing capabilities in surveillance and remote warfare but few would know that there are thousands of drones in the oceans, including in the Antarctic and often right under the sea ice.

This program started in 1999 so there has been a gradually increasing fleet of these drones over the last 15 years. They have since collected a mass of deep ocean data and will continue to do so at an ever increasing rate. Some 30 nations are involved in the Argo project, the USA being the biggest, followed by Australia.

How can these drones communicate and deliver their collected data? They are programmed for a 10-day cycle which continues for many years, until their batteries are exhausted. For most of that 10-day cycle, they float at around 1000 metres, drifting in the deep ocean currents. Then they sink to 2000 metres and then slowly rise to the surface, logging temperature and other data as they go. They beam their data to satellites and then submerge to begin the cycle again.

It is most important that all this data is collected and carefully analysed, for it will tell us much about the world's climate and how it is changing. Undoubtedly, it will tell us a lot more about the deep ocean currents and how they contribute to ocean temperature cycles which can run over many decades.

Some climate scientists believe that the current pause in "global warming" may be due to the excess heat being stored in the deep oceans. Maybe they are right but it could be many decades before the Argo drones demonstrate the truth of that notion. Arguably, the drone program may have to be considerably extended because great areas of the world's oceans are considerably deeper than 2000 metres.

This fact has been emphasised by the loss of Malaysian Airlines Flight MH370 which may be in very deep water indeed. So deep that very little of today's technology has any chance of finding it. Maybe the Argo drones might have found it if they had been equipped for such monitoring.

Actually, the Argo program must be regarded as an initial stage in exploring the deep oceans. While virtually all of the Earth's land surface has been fairly thoroughly explored, much of the world's oceans are about as well known as the far side of the Moon. For example, while we know that there are many thousands of undersea volcanoes, relatively little is known about their activity and how they might be affecting the undersea environment.

Perhaps in the future we will see undersea drones which don't merely drift with the ocean currents but which are actually self-propelled, skimming over vast areas of the ocean floor while they collect video and other data, returning to the surface to be recharged and then to be programmed again for other missions. Imagine how these might have expedited the search for Flight MH370 as pods of these things were launched, like robot dolphins, to search the seas.

Or perhaps such drones could be programmed to follow whale migrations, or monitor the life of large fish shoals as they roamed the oceans. It is an exciting prospect, is it not? It is gratifying to know that Australia is taking such a major part in the Argo project and it is to be hoped that we can similarly be involved in future exploration of the world's oceans.

Leo Simpson

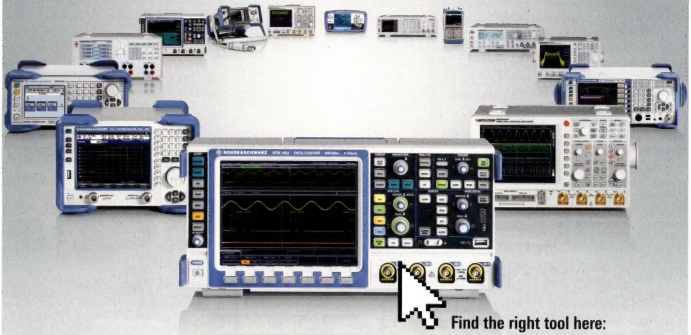
Value Instruments:
The quality you expect at an unexpected price.

Value instruments

High quality = high price? Not with our Value Instruments.
Value Instruments are versatile T&M instruments for everyday lab use.

- Quality T&M solutions engineered by Rohde & Schwarz
- Accurate, reliable, easy to use
- Comprehensive support thanks to the extensive service and technical support network

www.rohde-schwarz.com.au
sales.australia@rohde-schwarz.com



Find the right tool here:
www.rohde-schwarz.com/value

ROHDE&SCHWARZ

MAILBAG

Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

Suggestion for a simplified head-up display

I have been monitoring the interest in head-up displays (HUDs) in your magazine. I believe the main purpose of a HUD is to provide basic information to the driver without the need to take his/her eyes off the road or even focus on a nearer display.

I believe this could be economically and simply achieved with a single tricolour LED. My idea is that this tricolour LED would be positioned on top of the dash, reflecting in the screen. It would be green at the 'set' speed, blue below that speed and red above that speed, with the green covering a couple of km/h either side of the set speed. An enhancement could be flashing of the red about 5km/h above the set speed.

Setting could be done by pressing a button at the set speed or by turning a knob until the green LED lights up at the desired speed using the speedo (or tachometer) to provide the necessary information but only once for a given setting. This information would be retained until a need to change it arose, possibly at the next town, or retained long-term for a given situation such as highway speed.

Input of speed data could ideally be as versatile as possible to allow fitting to all vehicles independent of age or planned end use. I would envisage this unit being useful as an indication of more than speed, including optimum revs independently of gear and possibly to indicate the tacho red line.

The system does not even need the driver to focus on the light and it could easily be positioned wherever suits the driver or even directly viewed. Dimming at night would be required and in conjunction with this light there could be others for temperature and oil pressure which could be easily organised with existing systems based on frequency or voltage.

Jeff Montague,
Toora, Vic.

Comment: this project would require a microprocessor and not much other circuitry. We are not sure that most readers would want to settle for such a simple display, given that the micro could easily drive a 4-digit 7-segment display with little extra circuitry being required.

Belief in warming effect of carbon dioxide

While John McDonald (Mailbag, page 8, June 2014) is "absolutely amazed . . . people . . . are still being sucked into believing this global warming nonsense", I am absolutely amazed that, given the credible scientific evidence of the heating effect of carbon dioxide released by burning fossil fuels, there are people who still do not believe in anthropological-generated climate change.

Perhaps the common ground is that we both believe the climate is changing. Therefore, I propose a risk management approach to an issue that cannot be confirmed one way or the other before any necessary mitigation is too late to be effective.

"Rigol Offer Australia's Best Value Test Instruments"

RIGOL DS-1000E Series

- 50MHz & 100MHz, 2 Ch
- 1GS/s Real Time Sampling
- USB Device, USB Host & PictBridge

FROM $339 ex GST

NEW RIGOL DS-1000Z Series

- 70MHz & 100MHz, 4 Ch
- 1GS/s Real Time Sampling
- 12Mpts Standard Memory Depth

FROM $654 ex GST

NEW RIGOL DS-2000 Series

- 70MHz, 100MHz & 200MHz, 2 Ch
- 2GS/s Real Time Sampling
- 14Mpts Standard Memory Depth

FROM $934 ex GST

Buy on-line at www.emona.com.au/rigol

ElectroneX

electronics design & assembly expo

Design, Develop, Manufacture with the Latest Solutions!

In the fast paced world of electronics you need to see, test and compare the latest equipment, products and solutions for manufacture and systems development.

Showcasing new and future technologies in electronics

Register Online Now
www.electronex.com.au

Knowledge is Power

SMCBA CONFERENCE
The Electronics Design and Manufacture Conference delivers the latest information on a host of topics.

The last conference in Sydney attracted over 200 delegates and featured an impressive list of international presenters.

For conference details please visit www.smcba.asn.au

Make New Connections

- Australian & NZ based suppliers with the latest ideas and innovations
- New product, system & component technology releases at the show
- Australia's largest dedicated electronics industry event
- NEW technologies to improve design and manufacturing performance
- Meet all the experts with local supply solutions

In Association with
SMCBA ELECTRONICS DESIGN & MANUFACTURE CONFERENCE 2014

Organised by
AEE
AUSTRALASIAN EXHIBITIONS & EVENTS PTY LTD
Ph: (03) 9676 2133

Supporting Publication
SILICON CHIP

Australian Technology Park - Sydney 10-11 September 2014
www.electronex.com.au

Mailbag: continued

Concerns about wiring in Chinese electronic equipment

Recently, our test section took delivery of an inexpensive frequency counter directly from China. It was fitted with a flat US-style 2-pin mains plug but before I lopped it off to fit a 3-pin plug, I opened the unit to have a curious look around. The first thing that caught my attention was that the flimsy primary leads to the small mains transformer were bundled and cable-tied to the equally poorly insulated secondary leads. I doubt they would have withstood the standard one-minute 4kV isolation test.

The leads were duly separated but it soon became obvious that the fuse was wired into the Neutral lead of the mains cable. Given that this unit would only be earthed via the test lead plugged into the front panel, any Active-to-chassis internal fault would be effectively unfused, exposing the operator to both high voltages and/or high currents; a very unsatisfactory situation indeed.

However, before correcting this, my attention was drawn to the 5V regulator heatsink that was sitting crooked on the board. The corner of this bent aluminium shape was now less than 2mm from the solder pad that brought the mains lead up to the PC-mounted on-off switch. Here was exactly the type of fault that could put 240VAC on the test leads!

The heatsink was fabricated with oversized mounting holes that readily allowed it to slop over towards the mains switch. It had apparently been this way since assembly, as all the screws were tight.

Closer inspection of the PCB showed that in places, the 240VAC tracks came within 2.5mm of the chassis connected ground plane. This is well inside the 4mm standard practice for double-insulated equipment such as this and would certainly fail the isolation test.

A little work put all this right but poor design and poor assembly practice created a potentially dangerous situation that took the shine off the bargain price.

Incidentally, a few months earlier I had encountered a Chinese-manufactured power supply (this time from an Australian distributor) with no continuity from the chassis to earth. The mains earth lead was terminated in an eye-lug that was held against the chassis with a bolt and nut. The problem was that the painted chassis insulated the lug and the bolt. Obviously, their final factory tests do not include earth integrity.

End users of electrical equipment rely on the competency of designers and manufacturers for our very safety but in the case of Chinese origin gear, it pays to do a few simple checks yourself. Plainly, the mains wiring practices of some Chinese manufacturers are still dangerously inadequate.

Keep up the good work SILICON CHIP magazine. Your efforts are consistently world-class and well appreciated.

Mark Hallinan,
Sunnybank Hills, Qld.

Faced with a potential catastrophic 'show stopper' risk, best project management practice is to mitigate the risk. An astute project manager will do everything possible to reduce the risk no matter what the chance of it occurring. After all, if the risk comes to pass, all other effort is for naught.

There are two possible outcomes in this approach. First, mitigation action of reducing greenhouse gasses and preparing for environmental change is taken in a considered, orderly and affordable way (although I don't dispute that there is an actual cost in the same way that paying an insurance premium reduces disposable income for more enjoyable pursuits) and it turns out climate change is natural.

In this case many of the measures taken will be necessary to help mankind cope with the altered environment; a small "w" win as society and the economy cope.

Second, mitigation action is taken as above and the climate is being changed by mankind; a capital "W" win as society and the economy successfully adapt with the least cost and inconvenience overall.

For completeness of options, let's consider the alternative business-as-usual scenarios: nothing is done and climate change is natural. Money will still need to be spent in the future to somewhat ameliorate the effects of the changing climate on agriculture, dwellings, workplaces, transportation, infrastructure, medicine, defence, etc.

As any project manager will tell you, rushed 'fix the problem now' expenditure is always very expensive. Society and the economy will suffer a severe negative impact.

Finally, climate change is man-made. It's business-as-usual and, having ignored the warnings and continuing to exacerbate the effect, the worst case predictions are the future reality. Despite massive expenditure to finally deal with the issue, it's too little, too late as by this time climate change is unstoppable for over 1000 years. The massive expenditure and negative impacts on production drive the world's economies into severe depression. Over the millennium, society is turned upside-down trying to cope with the environmental, economic and dislocation effects of sustained climatic changes.

Considering the very likely outcomes of each scenario, I think the only sensible and safe option is to immediately discuss what is the appropriate balance of GDP to invest in greenhouse gas reduction technologies and climate change amelioration projects. Then implement the mitigation strategy without delay.

Despite the low risk and high premiums, no-one regrets having insurance when their house burns down. If there is any disappointment, it usually is: I wish I'd paid more to make sure I was fully covered.

Tim Herne,
Calwell, ACT.

In defence of climate modelling

George Ramsay's statement (Mailbag, May 2014) that scientists, using computer models, "extrapolate past

Embedded 3D Gesture and Position Tracking

with Microchip's GestIC® Technology

Microchip's patented GestIC® 3D Technology provides a **single-chip**, real-time gesture recognition solution. The MGC3130 enables the next breakthrough in user interface design for any product at a very low cost point.

MGC3130

- The MGC3130 runs the Colibri Gesture Suite, enabling robust recognition of complex 3D gestures without requiring any host processing
- The MGC3130 delivers the results (detected gestures/ XYZ positioning) to the host via an I²C™ bus interface or using GPIOs

Microchip Technology Australia
Tel: (02) 9868 6733 E-mail: aust_nz.inquiry@microchip.com

microchip DIRECT
www.microchipdirect.com

MICROCHIP

microchip.com/gestic

The Microchip name and logo, the Microchip logo and GestIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.
All other trademarks are the property of their registered owners. © 2014 Microchip Technology Inc. All rights reserved.

Mailbag: continued

A novel circuit for a GPS-disciplined OCXO

A while back, I wrote a criticism of your GPS-disciplined 10MHz standard (SILICON CHIP, March-May 2007 & September 2011). At the time my ideas for improvement were theoretical and as we all know "in theory, theory and practice are the same, in practice they aren't". To cut a long story short, the ideas have been incorporated in a design that bears little relationship to the original SILICON CHIP circuit.

The end result is built on stripboard as a 'proof of concept' rather than a finished product. Given that many readers would have more design skills, more test equipment and more use for the end product, I believe they should have no trouble adapting the design for their own uses. It is written up at **www.cashin.net/project1/index.html**

The design uses a commercial 10MHz OCXO (oven controlled crystal oscillator). Older used ones are available on a well-known site for less than $30. Apart from this and a GPS unit, the components are inexpensive and readily available. A PIC16F628A is used to discipline the OCXO and after some 'burn in' time, compares the GPS and OCXO over 3-hour periods. In a day or two, the OCXO settles to much better than one part in 10^{10}.

Original tests were done using a poor antenna location in the house, where the temperature is relatively constant. The worst case result after two days was two parts in 10^{11}, and better than one part in 10^{11} for most 3-hour periods. The rig is currently in a carport with the antenna in a favourable position (on the roof) but the rig is subject to more temperature variation. I expect to have the results for this location by the time this letter is published.

These results are in the same league as rubidium standards without any set-up procedure or age limit, costing the same or less and with the satisfaction of 'rolling your own'. If anyone is interested and wishes to correspond, there is an obfuscated email address at the link above.

Alan Cashin,
Isilington, NSW.

their set of data points" to "predict the future" reveals a misunderstanding of how current computer models forecast weather and simulate future climate. Such models are based on known laws of physics such as the conservation of mass, Newton's laws of motion, the first and second laws of thermodynamics, the laws governing radiative transfer etc.

These models integrate differential equations that describe the physical laws obeyed by the atmosphere, using the current state of the atmosphere (current weather) as a starting point. The equations are time dependent and so are predictive. Such models do not "extrapolate" from a prior sequence of data points!

The accuracy of the forecast depends on the accuracy of the input data, the resolution of the model and the inclusion in the model of all relevant physical processes. Clearly, unless the input data has infinite resolution and is perfectly accurate, unless all physical processes are included and unless the computer has unlimited speed and storage capacity, the forecast weather will diverge from the observed weather as the forecast period increases.

Most weather models would not claim to be accurate past about a week. So it is reasonable to ask how climate models can claim to "predict" the climate far into the future.

There are important inputs to models other than the current weather. Called climate forcings, these include boundary conditions such as surface type (soil, sand, water, snow, sea ice, vegetation, topography, albedo etc.), the composition of the atmosphere (particulates and gases including water vapour and greenhouse gases because they strongly influence radiative transfer) and the source of nearly all atmospheric energy, solar radiation. They are especially important in the long term; there are many more.

Suppose a model is run to simulate the weather over a long period, say decades. Now we are not interested in specific weather events but rather in averages. We have a climate model. The simulated climate (average weather patterns, temperature and rainfall distributions etc) during the period can be calculated and compared with real climate statistics.

If there is good agreement for past periods when climate forcings were known, then the model should be capable of simulating how the climate might change under differing forcing scenarios. For instance, what changes of climate might be expected if the concentration of a particular greenhouse gas were to double? What if particulates increase due to an immense volcanic eruption? What if sea ice disappears from the Arctic Ocean? What if Brazil is deforested?

If you are seeking additional information about Global Climate Models (GCMs), a good place to start is the Geophysical Fluid Dynamics Laboratory website at Princeton University, **http://www.gfdl.noaa.gov/climate-modeling**

Bob Lile, PhD,
Princes Hill, Vic.

Scepticism should be the basis of climate science

Just wanted to let you know I loved the Publisher's Letter in the June 2014 issue, on reducing clutter and organising stuff to make things easier for others later on etc. We've just been clearing out all areas of our house and the effect is brilliant. It seems to help clear the mind as well. My workshop is so much more functional. I used to feel overwhelmed by the sheer quantity of junk and unfinished projects, to the point of paralysis and stagnation.

Also, I wanted to express my appreciation for Leo Simpson's continued sceptical stance on climate change, despite the volume of critical mail you seem to be getting. I don't pretend to be at all knowledgeable in that area but to me the whole thing stinks, just on the basis of how anyone expressing the slightest bit of scepticism is labelled a "non-believer" and assumed to be in collusion with the evil polluters/miners etc or be politically motivated and have extreme right-wing views.

GET THE MOST OUT OF OUR OEM&ODM SERVICE

IS YOUR COMPANY AT RISK WITH THOSE HIGH EXPENSES?

TraceME modules can save your business a lot of money because:

- They let you track and trace all your possessions, big or small, from birds to vehicles, shipping containers, etc.
- They can keep track of your machinery's status and send warnings to your selection of mobile numbers and servers.
- They allow you to send customized updates wirelessly from a server to any of your TraceMEs in the field.
- They have countless onboard sensors and advanced software to reduce battery consumption to support all your operations. Sensors such as RFID, G-force, altitude, speed, temperature, etc.
- They are fully customizable to suit any situation.

46 x 21mm

MAIN FEATURES

GPRS AND HSDPA+
GPS AND GLONASS
RF (2KM RANGE)
MULTIPLE SENSORS

7 grams

We have a worldwide distribution and support network

www.trace.me

Email: krijn@kcs-trade.com.au | Fax: +61-(0)733-197-302
13 Mons School Rd, Mons 4556, Queensland, Australia

Mailbag: continued

Favourable experience with digital hearing aids

Over the years I have followed with considerable interest the SILICON CHIP articles on the Australian-manufactured hearing aids (initially Australia Hears, now Blamey Saunders Hears). I would like to add my comments to writer G. H. "Hearing Aids Are Too Expensive" (Ask SILICON CHIP, June 2014) and Ross Tester's response, the points of which are confirmed by my experience.

For some years, I had become increasingly dissatisfied with the sound from my fairly expensive hifi system, eventually thinking that the speakers mustn't be up to scratch. I also like listening to FM radio but I found the announcers' voices to be muffled and the music reproduction very ordinary sounding.

My wife, who suffers from several problems which affect her hearing, had an audiology test several years ago and also saw a specialist. But the downsides of a possible surgical procedure outweighed any potential benefits and she did not proceed down that path.

At that point we invested in two pairs of wireless headphones for watching those TV programs which we had difficulty hearing (strong English dialects, background music seemingly dominating actors' voices etc). On the other hand, with locally produced programs, we tended to use the set's loudspeakers with the volume fairly well advanced.

Several months ago we did the on-line Blamey Saunders hearing test and as a result my wife ordered a pair of their SIE-64 hearing aids with the programmer box. These aids are not cheap but are half the cost of what you would pay for those from an audiologist supplier.

After a few days use, she advised me to try her lefthand aid while we watched TV. The change was remarkable – the volume could be turned down and I could hear the voices with a crispness which I didn't realise existed! After several more days use, she fine-adjusted the aids using the programmer box, tweaking them to her satisfaction.

Next, I was encouraged to book an audiology test at our local National Hearing Care clinic, the results of which showed my high-frequency hearing to be poor, especially on the left side. So my next move was to order a pair of the SIE-64 from Blamey Saunders, attaching an emailed copy of these results to them so they could perform an initial set-up of the aids for me.

I have now been using the aids for several weeks and their performance is absolutely impressive. TV can be watched at considerably lower volume levels with good audibility (with the odd exception, as some DVDs require the use of the headphones as do some TV programs, due to accents and varying sound mixes). Listening to music via the hifi system is now a most enjoyable experience, with great treble and stereo emphasis from our CDs. There was nothing wrong with my speakers, after all!

As a further comment, the hearing aids do not restore one's hearing to what it may have been some years before but assist in smoothing the defects which have occurred over time, thus enabling a more enjoyable life. As the name implies, they are an aid, just as spectacles are an aid to deteriorating vision.

Yes, aids all have their downsides. After all, they are objects we have to wear and hence we notice them physically. But without them we can become less connected to friends and society. They are a crutch of sorts but where would the person with a broken leg be without crutches?

So as we age or suffer from a disability we employ the technology that aids us to enjoy life more fully. It can take a bit of adapting to but the end result is to my mind extremely beneficial.

Thanks for the magazine; sometimes controversial, always interesting.

Richard Kerr,
Millfield, NSW.

This is not what science is supposed to be about – scepticism is the basis of science. The IPCC seems to be a highly questionable organisation and as far as I can tell it's only them saying that 97% of scientists agree etc.

There are also still problems with the whole theory, the biggest of which that I know of is the fact that over the last several thousand years, increasing temperature has driven increasing CO_2 (ie, atmospheric temperature rose before CO_2 levels), which is the exact opposite to what the "eco-mentalists" are claiming is happening now.

The climate may be changing but as far as I can tell the links that "prove" it to be due to human activity (I have read amounting to an extra 3% CO_2 production over previous "natural" levels) are far from solid.

I guess it comes down to the whole "greenie" mentality that somehow humans are a blight on nature and all of our incredible achievements are unnatural. After all, what we are mostly doing that is supposedly wrecking the planet is simply striving to make our lives better and easier, which is surely as natural as it gets.

I love the parts of our planet that are unspoilt by humans and absolutely agree that they should be kept that way. But would I go back to living as a cave man? Absolutely not! Anyone so concerned that what humans do is unnatural should go back to living as a hunter-gatherer.

Keep up the great work; it's a fantastic and unique magazine.

Ionwyn Buckland,
Hornsby Heights, NSW.

Problems with isolation transformer article

I refer to an article in the May 2014 issue of SILICON CHIP, where a mains isolation transformer is assembled by employing two identical step down transformers with the low-voltage windings connected together, the idea being that the power mains is stepped down to 12VAC and then stepped back up to mains potential, in this case

230VAC, with an available power of 920 watts.

So far so good except that the 12V windings on both transformers need to be equipped with windings capable of delivering or accepting about 78A. Judging from the photograph on page 86, this would appear to be quite unlikely. Furthermore, the secondary wiring from the transformers certainly appears far too thin to carry such a high current. The power rating of 920W is assumed because of the 4A maximum output current stated at 230V.

Fig.3 on page 86 of that issue shows a 3A fuse wired in series with primary winding of the input transformer while the picture on page 87 shows the output GPOs labelled to deliver up to 4A. One begins to wonder how many people were involved in the article being described because the input current will exceed the output current for a number of reasons. They are primarily due to the need for the input transformer not only requiring its own magnetising current but also needing to supply the output transformer's magnetising current.

In other words, the input current will be measurably higher than the current delivered to the output load. It appears that no reduction in output voltage has been taken into account due to I^2R losses. The losses will also vary according to output current.

It would appear that the writer of the article has taken the wattage of the transformers to be the same as the VA rating because the rating of the UPS from which they were removed claims a VA rating of 920. If this is the case, the writer is wrong. VA is derived by dividing the power in watts by the load power factor.

A typical monitor-computer combination that forms the load for a UPS exhibits a power factor of 0.6 so by manipulating the formula to find power, we need to multiply the VA by the power factor; for a VA of 920 and a load power factor of 0.6 we obtain a power of 522W or a current of 2.27A, not 4A as suggested. I would suggest the input fuse for such an arrangement be of the order of 4A slow-blow.

It should be mentioned that the transformers employed the article are designed to operate for a relatively short time, say between five and 20 minutes, depending on the load current when using a typical 12V SLA 7Ah battery in a UPS. During standby, the input current only has to be sufficient to maintain the battery voltage near full charge. Thus heating of the transformer will be minimal, whereas during the power supply mode the heating of the transformer is considerable and is not designed for continuous use.

Finally, I still have reservations about the current ratings of the 12V windings on the transformers (14V CT in the text!). Even with a power rating of 522W the 12V windings will need

Damn you, Micromite!

I'm a retired engineer living in Tasmania and my imagination was sparked by your article on the Micromite in the May 2014 issue of Silicon Chip. My discovery of the Arduino MCU development platform last year prompted me to take up electronics again as a hobby (much to the delight of parts suppliers). I am more familiar with the BASIC programming language, in its various permutations but thought that the 'C' language, being compiled rather than interpretive, was the way to go.

Having bought a few books about the Arduino, learnt all about the IDE and taught myself to program in 'C', along comes the Micromite and MMBasic. So damn you Micromite! I guess the PIC32MX MCU is that fast and powerful, who cares if it's running BASIC!

However, I do believe there is an error in the said article on page 36, where the text description of the NMEA date and time fields for the GPRMC message type are the wrong way around. 'Date' should be the tenth field and 'Time' the second. The program is correct.

As an avid reader, in the past, of "Practical Electronics", "Electronics Australia" and "ETI", I am now a happy subscriber to Silicon Chip. Keep up the good work!

Tony Barrett,
Queenstown, Tas.

Mailbag: continued

Isolation transformer's output socket must not be earthed

I love your articles in "Salvage It". I was brought up in the days of "make do and mend" and "waste not, want not". Nothing useful was ever thrown away. I still adopt that attitude today although it can make access to my shed a trifle crowded.

I have a concern over the safety aspect of your design for the isolation transformer. In your bid to make the most use of the salvaged components you have included the double GPO. In so doing, this has completely defeated the whole point of such a device, which is to isolate from earth and all other live equipment.

If two operators were to use both outlets at the same time for connecting two pieces of equipment it is no longer isolating anything. The idea of isolating transformers is to totally isolate any appliance from all connections which may accidentally become earthed. This allows a person to handle a "live" chassis without forming a return path to earth through their body.

If two appliances are connected at the same time then a person handling one of these immediately forms a return path to the other appliance. Each appliance then becomes "live" with respect to the other and would electrocute both operators.

Similarly if an appliance with an earth fault were plugged into an earthed socket then the isolation is immediately lost. For these reasons Australian Standard AS3000 clause 5.3.9.1 states "An isolating transformer shall supply only one item of equipment at low voltage".

I think that it may be worth producing a safety information article for your readers who may have a need to use an isolation transformer as they may be tempted to plug in double adaptors etc.

Keep the recycling ideas coming; the world needs your help.

Keith Brown,
Robe, SA.

Comment: you are certainly correct that the output socket of an isolation transformer must not be earthed. Interestingly, we have two isolation transformers in our laboratory, one rated at 240W and one at 1kVA (a very heavy beast). We have included photos of the smaller unit to show its warning that the secondary must not be earthed. Furthermore, the earth pin of its 3-pin output socket is not connected.

However, with respect to Australian standards, while the reference clause 5.3.9.1 is in the 1986 edition of AS3000 it is not in AS3000:2007. However, there is mention in clause 4.14.3.2 with respect to earthing where it says that: "Exception: where the low voltage transformer output complies with the requirements of the AS/NZS 61558 series, earthing is not required on the secondary side". Typical commercially-made isolation transformers comply with AS/NZS 61558 2.6. The old standard was AS3108. Only one output socket should be fitted.

We have modified the article published in the May 2014 issue and it is now in the on-line edition available from our website. The changes also reflect the comments made in Victor Barker's letter on pages 11 and 12.

This small isolation transformer in the SILICON CHIP laboratory has a single 3-pin outlet and includes a warning on the label on top stating that the secondary must not be earthed.

to be rated at 43.5A and the wiring will need to accommodate this value.

I also make the point again that the output voltage will always be less than the input voltage. I therefore suggest that using back-to-back transformers for isolation purposes, despite the cost advantage, may not be such a good idea.

Victor G. Barker, VK2BTV,
Gorokan NSW.

Comment: we agree that the transformers featured in the May 2014 issue would not be able to provide an output of 920W. Judging from the size of the transformers' cores, a more realistic rating would be no more than about 200-250W.

Such an appliance would be very handy when doing repairs or tests on equipment with live chassis.

Too much signal from cheap video cameras

I noticed in the Ask SILICON CHIP pages of the May 2014 issue that P. M. complained of a weak and washed out video signal from a reversing camera. I had a similar problem with both a "sugar cube" black and white camera and a small colour camera used for security etc.

At first, I thought that it was due to the fact that both cameras were cheap. But in attempting to solve the problem, I had been referring to two "Electronics Australia" projects: the Frame Grabber in August 1989 and Slow Scan TV in July & August 1990.

What caught my eye was the input of the latter. The designer, Leon Williams, had fed the video signal into a 1kΩ potentiometer and labelled it as "contrast"

So I simply placed a grounded 1kΩ pot between the camera and my display, which was an Acer computer monitor with multiple inputs, including composite video. On adjustment, I was able to get a crisp, well-defined picture from either camera. Contrary to what I thought, they were both capable of producing good pictures.

The washed-out video from my cameras was due to the signals being too strong, not too weak. Perhaps that is the case for P. M. as well.

George Ramsay,
Holland Park, Qld.

Isolation transformer should not have a double outlet

What a good idea to make an isolation transformer from the two UPS transformers, as depicted in the May 2014 issue. However, I think that your readers and users of the isolation transformer should be aware that the original isolation transformers sold in this country (eg, Saf-T-Pac) had a shield around the outlet socket to prevent double adaptors being inserted and a warning that more than one item/tool/appliance should not be used with the transformer at one time.

The reason is that if one of the devices connected to it has an earth fault, it means that the secondary of the output transformer would no longer be isolated from earth, thus defeating the purpose of the device. Your version has a double outlet and users should be warned to replace that with a single general purpose outlet and also warned against using two devices on it concurrently.

Peter Chalmers,
Clear Mountain, Qld.

Ethernet over mains may not work across phases

I have just read Leo Simpson's article in the June 2014 issue. It reminded me of the issues I dealt with in retrofitting gigabit Ethernet to my home. We now have eight cabled points and two wireless access points to cater for all manner of desktop and mobile devices.

During the planning stages, I considered the Ethernet via mains option but ultimately opted for cable because I could not get a straight answer on how the 'via mains' system would function in a house whose mains power is 3-phase.

I suspected that the 'via mains' system might only operate within one phase and not across phases, as the three phases are separate circuits.

Am I correct on this and if this is a limitation, is it worth drawing it to the attention of readers who might be considering installing this system?

Robert Allan,
Hunters Hill, NSW.

Leo Simpson comments: I do not have 3-phase wiring in my home so I do not know the answer. I think your doubts are justified. Ultimately, your wired system is likely to be superior which is fine if it can be installed reasonably easily.

1ms pulse interface information available on Microchip website

With respect to the question concerning a 1ms interface in the Ask SILICON CHIP pages of the May 2013 issue, the Microchip application note AN847 covers this in some detail. Also AN905 (Brushed DC Motors) is a good reference.

Both are available at no cost from the Microchip website.

Keep up the good work with SILICON CHIP.

Mike Abrams,
Capalaba, Qld. SC

SIGNAL HOUND

USB-based spectrum analyzers and RF recorders.

SA44B: $1,320 inc GST

- Up to 4.4GHz
- Preamp for improved sensitivity and reduced LO leakage.
- Thermometer for temperature correction and improved accuracy
- AM/FM/SSB/CW demod
- USB 2.0 interface

SA12B: $2,948 inc GST

- Up to 12.4GHz plus all the advanced features of the SA44B
- AM/FM/SSB/CW demod
- USB 2.0 interface

BB60A: $3,663 inc GST

- Up to 6GHz
- 1PPS input for GPS time-stamping of recorded RF streams
- Simultaneously monitor two stations or stream the entire FM radio band to disc
- USB 3.0 interface

Vendor and Third-Party Software Available.

Ideal tool for lab and test bench use, engineering students, ham radio enthusiasts and hobbyists. Tracking generators also available.

Silvertone Electronics
1/8 Fitzhardinge St
Wagga Wagga NSW 2650
Ph: (02) 6931 8252
contact@silvertone.com.au

Silvertone

This photo shows an Argo float being deployed into the ocean, although they are not normally thrown off the side of a ship as shown here. The usual method is to lower them gently into the ocean in a cardboard box to protect them hitting the side of the ship. The box is in a sling with a quick release on the bottom. When the box hits the water, a starch tablet in the bottom dissolves and the biodegradable box floats away, releasing the float.

Argo: drones of the deep oceans

By Dr DAVID MADDISON

Right now, thousands of drones are floating deep in the oceans of the world, monitoring temperatures and other data. They are fully autonomous and they can change their buoyancy to sink deeper or rise to the surface to send data to satellites.

MOST PEOPLE know about drone aircraft and their many types and capabilities but did you know that there are thousands of drones in the deep seas? Over 3600 such drones are quietly floating at around 1000 metres deep in the oceans of the world, monitoring temperatures, salinity and other parameters. Not only that, they also regularly descend to 2000 metres, then slowly float up to the surface, taking measurements as they go and then they beam their collected data to satellites.

After transmitting their data they submerge again, endlessly repeating the cycle, unseen and autonomous for many years, until they reach the end of their lives due to misadventure or battery failure.

This is Argo, an international project involving 30 countries including Australia. It consists of thousands of free-ranging ocean floats that monitor the temperature, salinity, currents and other parameters of the ocean. Data from the floats is used in the study of oceanography and climatology.

Important data

The data obtained from Argo is important because it is acquired rapidly in near real-time and can assist in short and long-term weather forecasting, monitoring of long-term trends in the ocean, monitoring of ocean currents and for other weather, climate and oceanographic research.

Until recent times, ocean temperature and other measurements have been made by research ships or commercial or military ships participating in the Voluntary Observing Ship scheme. But such measurements are limited in scope and follow the main shipping routes. In addition, because of the greater volume of shipping in the Northern Hemisphere, there was far more data from there than from the

Southern Hemisphere, where there also happens to be a greater volume of ocean.

How does it work?

So how do the Argo floats sink to 2000 metres deep or rise to the surface? They do it by controlling their buoyancy. Fig.1 shows a cross-section of a typical Argo float; they are essentially a cylinder which is more than 1.1 metres long and they float vertically.

At depth, the buoyancy is controlled by an external hydraulic bladder at the bottom. To make it rise, a geared motor drives a rod which pushes down a piston in a cylinder filled with hydraulic fluid (oil). The hydraulic fluid inflates the bladder and the float then displaces more water, increasing its buoyancy and up it goes.

To reverse the process, the motor retracts the piston and the fluid from the bladder is forced back into the cylinder, reducing the buoyancy and accordingly, the Argo float sinks. The process is quite precise as the pressure is monitored by a sensor adjacent to the bladder. As we shall see, the water depth is directly proportional to the pressure, and vice versa.

Extra buoyancy is required when the float reaches the surface to ensure that the antenna is clear of the water. This is provided by a pneumatic bladder which can be inflated by another pump.

A typical float weighs 20-30kg. Sensors at the top of the float monitor temperature, salinity and other parameters, depending on the particular model of Argo float. An antenna at the top of the unit sends the data to a satellite. That broadly describes an Argo float but there are many variations, as described later in this article.

Argo was conceived in 1999 when international organisations met to discuss creating a more coordinated approach to the gathering and distribution of oceanographic data. Following this meeting, a group of scientists developed a plan to have a 3000-float array in place by 2007 and this objective was achieved, the first floats having been deployed in late 1999.

The figure of 3000 floats was arrived at by a requirement for each float to sample a roughly 3° x 3° latitude by longitude area between 60° north and 60° south. Higher latitudes were initially excluded because of the problem of the floats becoming entangled with sea ice and polar ice-sheets. There is now a program to deploy polar floats which will be discussed later.

In 2009, suggestions for further improvements to the array were made such as providing extra coverage in certain areas and adding chemical and biological sensors to the floats. By November 2012, the one millionth "profile" (data set) of temperature and salinity had been gathered which represented twice as much data as had been collected by research vessels over the entire 20th century.

At the time of this one millionth profile, 120,000 profiles were being collected every year or about one every four minutes, each profile consisting of up to 1000 temperature and salinity measurements.

The information that can be gained from the study of Argo data includes:

- Measurement of ocean temperature over a range of depths.

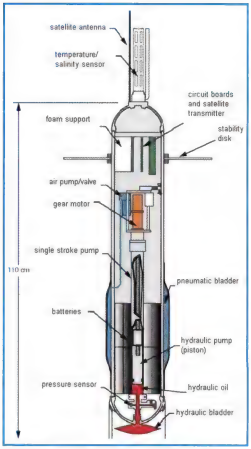
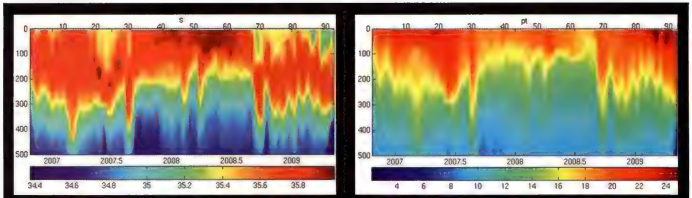


Fig.1: cross-section diagram of typical Argo float. Note the pneumatic bladder in this model. This is inflated near the surface to ensure the float rides high enough so that the satellite antenna is clear of the water.

- Measurement of ocean salinity over a range of depths that can reveal where the ocean has become less salty due to rainfall or river outflows and more salty due to evaporation or by the flow of ocean currents with various levels of salinity. This leads to insights into the hydrological cycle.
- Measurement of ocean circulation and temperature characteristics which lead to phenomena such as El Niño (an abnormal band of warm water of greater than 0.5°C above average that periodically develops off the coast of South America causing adverse weather events in Australia and many other countries); the Pacific Decadal Oscillation – sea surface temperature anomalies which affect climate in western North America, Siberia, India and Australia; and other similar phenomena.
- Accurate mapping of ocean circulation.
- Seasonal variations in the ocean and long-term variations.



Figs.2&3: these two plots show data from a float deployed off Western Australia, in the Leeuwin Current that runs south along the WA coastline. Fig.2 at left shows salinity versus depth, while Fig.3 at right shows temperature versus depth down to 500 metres. The x-axis of each is time in years while the y-axis is depth, in metres. The legend at bottom shows the correspondence between colour and either salinity (in parts per thousand) or temperature (in °C).

Of special interest to some researchers is the heat content of the oceans. A 3-metre column of ocean water contains as much thermal energy as the entire height of the atmosphere of the same column diameter. Knowing the temperature and other parameters of the ocean and how heat is exchanged between the ocean and the atmosphere is important for understanding the climate system.

A typical Argo mission

A typical Argo float mission is 10 days. It involves sinking from the surface to a depth of about 1000 metres and parking at that location for around nine and a half days while it takes temperature, salinity, pressure (equivalent to depth) and other measurements the float is equipped to take; see Fig.8.

A depth of around 1000 metres is typically chosen as it is usually a region with minimal current and the float will not drift away too far from its desired location. Following the parking period, the float drops to a depth of about 2000 metres and then proceeds to rise to the surface over a period of eight hours during which it takes further temperature, salinity, pressure and possibly other measurements along the approximately 2000-metre water column, depending on which sensors the float is equipped with.

Pressure equals depth

Note that in oceanography, water pressure, measured in decibars (dbar or db), is used as a measure of depth (in metres). One bar roughly equals one atmosphere and a decibar is roughly 0.1 atmospheres. The pressure in decibars is for most practical purposes the same as the depth in metres, so that an increase in depth of one metre equates to increase in pressure of one decibar; 100 decibars is 100 metres. While pressure in the ocean would comprise the depth of water plus the atmosphere, the relatively small contribution of the atmosphere is ignored so at the surface, the pressure is considered to be 0 decibars.

The precise conversion formula between decibars and metres of depth in the ocean can be found in a panel later in this article.

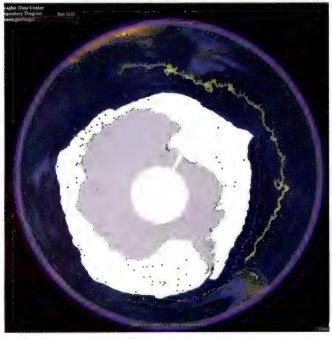


Fig.4: this is the path of an Argo float revealing the Antarctic Circumpolar Current. At the time of this image, the float had been deployed for six years, reporting a 2000 metre profile every 10 days while drifting at a depth of 1000 metres between reports.

Argo floats can phone home

Argo floats communicate by one of two methods. Older floats typically communicate to the Argos satellite which is a general-purpose environmental data receiving satellite, not specifically associated with the Argo program despite the similar name. Newer floats use the Iridium satellite phone network. Essentially, they make a phone call to the relevant Argo data centre.

Older floats which communicate with the Argos satellite have to sit on the surface for 12-26 hours in order to transmit their 78 data points to the satellite. They can only store one profile at a time. These long surface times mean that wind and surface currents can move the floats away from their intended location and they can even wash up on shore.

Another risk of long surface times is that they will be spotted by fishermen and picked up when they should be left alone. This is a major reason for Argo floats, particularly in the tropics,

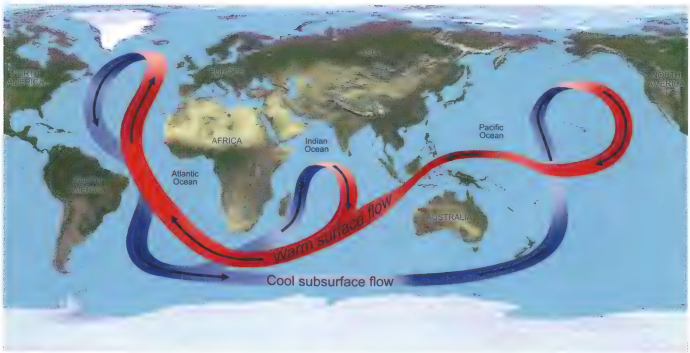


Fig.5: this is a general model of oceanic circulation, also known as thermohaline circulation or the "Global Conveyor Belt". It's driven by differences in water temperature and salinity which affect the density of seawater. In general, warm shallow water cools and sinks in the North Atlantic and deep cold water returns to the surface in the Indian and Pacific Oceans where it again warms. Argo can help monitor these currents, measuring temperature and salinity, and determine if any changes take place.

sometimes ending up in remote fishing villages in the middle of nowhere!

Since the older floats don't have GPS, their location is determined by calculations involving Doppler shift of the radio signal.

Newer floats which communicate via the Iridium network only require a surface time of around 15 minutes and can store up to 1000 data points per profile and 60 profiles. Their location is determined by GPS.

One might wonder if the floats constitute a shipping hazard but there have been no incidents. Their time at the surface is relatively short and since they are generally far away from shore they are not likely to be hit by small speedboats. In any case, there is vastly more natural and man-made debris floating in the ocean, much of it larger than the floats.

Australia is a big player

The USA has the largest number of Argo floats while Australia has the second largest, representing about 11 percent of the total number (see Fig.6). Argo in Australia is operated by CSIRO Marine and Atmospheric Research in Hobart, with support from the Bureau of Meteorology, IMOS (Australia's Integrated Marine Observing System), the Antarctic Climate and Ecosystem Cooperative Research Centre, the Royal Australian Navy and the Department of Climate Change and Energy Efficiency.

Worldwide, the Argo program is sponsored by the World Climate Research Programme's Climate Variability and Predictability project (CLIVAR) and by the Global Ocean Data Assimilation Experiment (GODAE). It is a pilot project of the Global Ocean Observing System (GOOS).

There are about six major manufacturers of floats plus some minor ones. The Argo program does not specify the exact design of each float but does specify required performance data such as accuracy, type of sensors and float and battery life.

Since the exact specifications are not defined it allows manufacturers to come up with better, more efficient and more capable designs and also allows float costs to be reduced. A typical float costs around $21,400 although the total deployed cost including the cost of the float, a ship to deploy the float and staff is around $35,000.

Argo floats used in Australia are disassembled and undergo a thorough check before deployment and older models had their alkaline battery packs replaced with lithium ones. As a result of these pre-deployment checks,

Jason & The Argonauts

The name Argo derives from Greek mythology and is the name of the vessel in which Jason and the Argonauts went looking for the Golden Fleece. Argo also works in a complementary manner with the NASA Jason satellites to measure sea levels.

Jason provides extremely accurate measurements of the sea level (to a few centimetres with complimentary gravity data from the NASA GRACE mission), while Argo provides measurement of salinity and temperature. This gives the contribution of water density (derived from temperature and salinity) to sea level which helps both validate Jason satellite data and also helps determine the contribution of sea level due to changes in the density of the water as opposed to extra water mass being added to (or removed from) the oceans such as that due to melting (or formation) of land-based ice.

Fig.6: this diagram shows the global distribution of floats and country of origin. The US has the highest number of floats (2000) while Australia has the second highest with 386. France has the third highest number of floats, with 256. Note that these are representative locations for a certain point in time only as the floats do drift around.

Argo floats in the Australian fleet have very good longevity.

The lifetime of older floats was manufacturer-rated at 3.5-4.5 years but due to the battery upgrade they have lasted up to 10 years. Currently deployed floats have a typical lifetime of 7-8 years because of a more complex mission profile and more measurements being taken, resulting in a reduced battery life.

This lifetime refers to time out in the ocean before the batteries go flat as the floats are not usually retrieved.

When the battery fails, the float is usually unable to rise from its approximate 2000 metre depth as there is insufficient battery capacity to re-inflate the buoyancy bladder. There it will remain indefinitely, never to be retrieved.

Note that while failed Argo floats are not usually retrieved due to the difficulty and expense of doing so (which would exceed the value of the float), if it comes to the attention of the Argo organisation that one has come ashore in an inhabited area or has actually fallen into someone's possession, it is important that it is recovered. This is because the large lithium-ion battery pack could be a safety hazard in the wrong hands, especially if treated inappropriately.

In addition, if traces of water have entered the float, there could be an explosive and toxic mix of hydrogen, oxygen and chlorine gas, due to electrolysis of seawater by the battery.

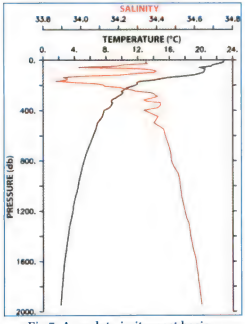


Fig.7: Argo data in its most basic form, showing a plot of temperature and salinity versus pressure (depth in metres) for a given position in the ocean.

Making An Argo Globe

You can make your own world globe in the form of an icosahedron showing the location of Argo drifters for a given day. The image can be found at: http://www-sci.pac.dfo-mpo.gc.ca/data/projects/argo/images/icosa.tif and assembly instructions can be found at: http://www.pac.dfo-mpo.gc.ca/science/oceans/Argo/documents/Argo_icos.pdf

Sensor accuracy

Since large amounts of scientific data are derived from the floats and that data is further incorporated into climate, oceanographic and other models, it is extremely important that the float sensor data be as accurate as possible. Temperature accuracy is ±0.002°C, salinity is within 0.02 parts per thousand and pressure is within 2.4 decibars.

This is a very high level of accuracy

so scientists can have great confidence in the results.

In regards to the missing Malaysian Airways flight MH370, the floats obviously have no capability to directly locate the wreckage. However, data from the floats feeds into and is the major contributor to the ocean current models that were used to track and predict the possible location of the crash debris.

The most energy consuming process in the floats is changing the buoyancy to make the float rise or fall. Forcing hydraulic fluid into an external bladder at a depth equivalent to 2000 decibars, or around 1975 metres (ie, where Argo descends), requires a significant amount of energy. At that depth the pressure is around 200 atmospheres (20 megapascals or 2900 psi).

Note that the exact depth where 2000 decibars occurs varies slightly according to the latitude. It equates to 1971.7 metres at ±60° degrees latitude, 1976.1 metres at ±35° degrees latitude and 1979.55 metres at the equator.

Accessing the data

Anyone, including SILICON CHIP readers, can access the Argo data for free and make their own discoveries. A website at http://wo.jcommops.org/cgi-bin/WebObjects/Argo has gateways to the two global data centres and also other information. The US Global Data Center (the other is French) can be accessed at http://www.usgodae.org/argo/argo.html

Data for the Australian Argo array can also be seen at: www.cmar.csiro.au/argo/tech/index.html and www.marine.csiro.au/~gronell/ArgoRT/index.html

Fig.8: a typical Argo float mission. The float descends first to 1000m and then to 2000m, switches on its sensors and then floats to the surface so that the collected data can be transmitted to a satellite. The satellite data is then downloaded to a ground station.

Interestingly, in March 2013 the data centres were hit with a huge number of downloads involving computers from all over the world and hundreds of gigabytes of data. The reason was a mystery until it was discovered that it corresponded to the film "Argo" being given three Academy Awards and people were looking for free downloads of the movie. Naturally, they would only have downloaded raw Argo data, not video.

Recent developments

The Argo platform is very flexible and as noted above, is not strictly defined in terms of shape etc. This allows floats to be developed with a

What Happens When They Float Ashore?

Occasionally, Argo floats wash up on beaches or are otherwise found and it can involve some real detective work to track them down. The main reason for the need to recover such floats is that the large lithium battery inside them can be a safety hazard in the wrong hands.

In one case, a float was deployed by the San Diego-based Scripps Institution of Oceanography near New Caledonia. It failed to surface after about 18 months and its last known location was off the coast of Mooloolaba in Queensland.

It was then actually trawled by a fisherman who thought it would be a good idea to turn it into a letterbox but it was spared that fate due to the intervention of CSIRO scientist Dr Ann Thresher who is in charge of Argo Operations.

Once the float was brought to the surface by the fisherman, it started broadcasting its location again. The precise location could be determined to only about a block and Dr Thresher travelled from Hobart to find it. She initially failed to do so and decided to return home but then changed her mind, more determined than ever to recover it. She went to the yacht club and then the fishing boats and after showing a picture of the device eventually found the fishing boat crew that had retrieved it.

This photo shows the sensor head of the float recovered off Queensland. After spending 18 months on the sea floor, it was fouled with barnacles.

The device was then collected and returned to the CSIRO for examination.

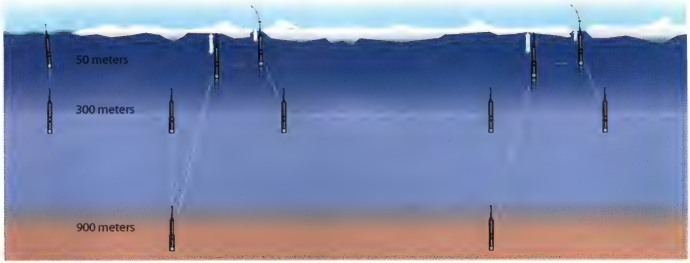


Fig.9: how the Argo floats cope with surface ice. The float will only rise to the surface to transmit data if the surface is ice-free, otherwise the data is stored until a break in the ice is detected. Contrary to what is shown in this diagram, in the current operational scheme, if there is overhead ice detected the float descends again to about 1000 metres and continues its 10-day mission cycle. As the floats used in such areas can store a large number of profiles, they can make many attempts to surface (at intervals of 10 days) until success is achieved.

wide variety of sensors to suit different applications. Newer floats may contain oxygen sensors, transmissometers to measure water turbidity (a measure of the biological productivity of water), an FLBB device (fluorometer/backscatter combination sensor) for chlorophyll measurement and measurement of nitrates, and a variety of other sensors.

In Australia, these new "Bio Argo" floats will be deployed this year in places such as the Bay of Bengal, as part of an Australia-India collaboration and off the north-west coast of Western Australia. These floats will mainly work at a depth of 300 metres. Incidentally, some of the more restrictive countries of the world will not allow Argo floats that collect biological data into their oceanic territories, presumably since it has implications for fishing policies etc.

A particularly interesting sensor has been developed that measures the electric field produced when (conducting) seawater currents move through the Earth's magnetic field. This is usually called motional induction. It allows the direction and speed of ocean currents to be determined. The specific type of Argo float that carries this sensor package is called the EM-APEX or ElectroMagnetic Autonomous Profiling Explorer.

The float contains a compass, accelerometers, magnetometers and a processing system to convert voltage differences measured by sensor electrodes to velocity components of the ocean current. This float also measures salinity, temperature and pressure, as do the other floats.

Coping with ice

Looking into the future, a number of new varieties of Argo are envisaged. Bio Argo has already been mentioned. As stated, the initial deployment model for Argo excluded the high-latitude regions because of the possibility of entanglement and destruction in the sea ice. These issues have now been resolved with new ice-hardened floats with features such as antennas that are resistant to ice and also methods of detecting overhead ice.

Overhead ice can be avoided by the float sensing a temperature close to the surface consistent with sea ice and then descending again if ice is expected. The float can stay submerged for a long time if necessary as numerous data sets can be stored and then transmitted to the Iridium satellites. Australia has deployed 29 floats in the seasonal ice region of Australia's section of the Southern Ocean.

Other future planned developments include a total fleet of 4500 floats and deep-profiling floats that go to 4500 or 6000 metres.

Argo is providing unprecedented amounts of information about the ocean environment. It is a major part of the world's ocean observing system. Among many other things, it should increase the power of predictive models of short-term and long-term climate forecasting, patterns of ocean currents and present and future trends in the global climate, as well as provide information on the interaction of both the shallow and deeper ocean with the atmosphere.

New developments also allow monitoring of the biological productivity

Converting Pressure To Depth

Based on UNESCO Technical Papers in Marine Science No. 44, gravity at a specific latitude and pressure is given by the following empirical, computationally-friendly equations:

$$g\ (m/sec^2) = 9.780318 * [\ 1.0 + (\ 5.2788 * 10^{-3} + 2.36 * 10^{-5} * x\ ) * x\ ] + 1.092 * 10^{-6} * p$$

where x = [sin (latitude ÷ 57.29578)]^2 and p = pressure (decibars)

Depth is calculated from pressure as follows:

$$depth\ (metres) = [((-1.82 * 10^{-15} * p + 2.279 * 10^{-10}) * p - 2.2512 * 10^{-5}) * p + 9.72659) * p] \div g$$

where p = pressure (decibars) and g = gravity (m/sec^2)

These formulae assume a certain water temperature and salinity. In reality, the difference between depth in metres and decibars is so small as to be of little practical significance.

The Argos System Satellites

OLDER AUSTRALIAN Argo floats transmit their data via the Argos System satellites. While the names are similar, there is no direct relationship between the two programs, apart from the fact that Argo uses the general purpose Argos satellite system. These satellites are designed to receive and disseminate data of a primarily environmental nature from both fixed and mobile platforms around the world.

Applications include but are not limited to:

- Tracking land and marine wildlife such as sea turtles, fish, birds and land animals fitted with miniature transmitters;
- Receiving environmental data from fixed and floating marine platforms (manned and unmanned);
- Monitoring of disease outbreaks, food shortages, therapeutic drug availability and humanitarian aid resource utilisation in Third World countries (via aid-worker mobile data terminals). This data is relevant to public health and aid authorities and the system can even monitor school attendance rates;
- Monitoring the climate via Argo and many other floats and buoys;
- Monitoring of global water resources such as river levels, snow fall, dams and the status of water distribution infrastructure;
- Monitoring fishing vessels via transmitters installed on them to ensure compliance with national and international fishing agreements;
- Tracking of adventurers in extreme environments and international yacht races;
- Improving maritime security by allowing shipping operators to keep constant track of their fleets, with all ships of over 500 tonnes gross being required by the International Maritime Organisation (IMO) to have a Ship Security Alert System (SSAS) installed.

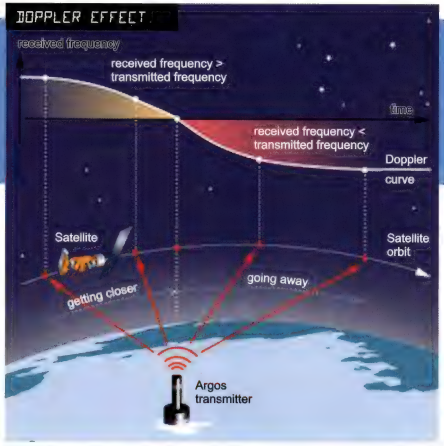


Fig.10: diagram showing the direction of Doppler shift as an Argos satellite approaches and then retreats from a transmitter.

Argos satellites are able to receive location data from GPS equipped transmitters but can also compute position data from platforms not equipped with GPS by utilising the Doppler shift of several received signals over a period of time. This is the same technique by which the rough location of the missing Malaysian Airlines Flight MH370 was determined. In practice, locations can be determined with an accuracy of 150 metres using Doppler shift as opposed to a few metres with GPS.

In Doppler location, the Argos satellite records the precise frequency of the received signal for every message received. Several messages need to be received in order to obtain a positional fix in order to generate a Doppler shift 'profile' of how the frequency changes as the satellite first approaches and then recedes from the transmitter.

At some point in the frequency versus time profile there is an inflection point representing the true transmitter frequency. The orbit of the satellite is known, as is the altitude of the transmitter, leaving the latitude, longitude and the true transmission frequency of the signal unknown for each transmission. These unknowns can be determined with two or three messages but a fourth message is required to completely solve the equations and determine the positional accuracy.

The solution to the equations provides two possible locations and then plausibility tests are used to determine the actual location as one solution will most likely represent an unrealistic position of the platform.

The latest Argos-3 satellites represent a significant improvement over previous versions and have 2-way communication, better transmission management (eg, acknowledgement that data was correctly received) and the possibility of platform remote control and programming.

of the ocean which might lead to new sources of sustainable fishing and other marine food sources (and may also indicate where these resources are being depleted, to give fisheries a rest). Other benefits of Argo are that it fosters international collaboration and helps in the development of global environmental information databases. It is widely supported internationally, Australia is a major player and the future looks very bright. SC

AmScope Stereo Microscope

a boon for working with surface-mount devices

How you do cope with assembling PCBs with surface-mount devices? You can always inspect the solder joints with a magnifying glass after they have been made. Or perhaps you use a large illuminated magnifying glass while you solder. But the "deluxe" way is to use a stereo microscope.

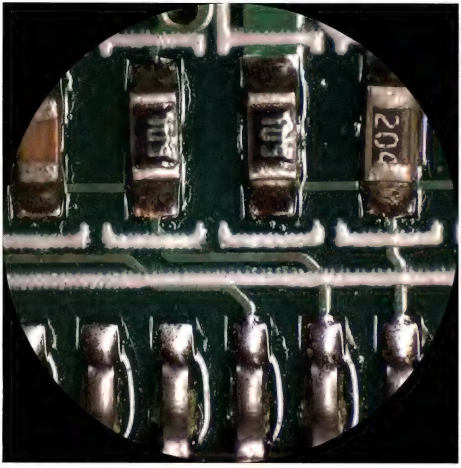
These days it is more or less impossible to avoid surface-mount technology if you are involved in building or repairing electronics.

Almost all the really interesting devices seem to be available only in fine-pitch or leadless packages. Rather than fight this trend, I have been working quite happily with SMT technology for many years and have developed an armoury of tools and techniques to cope with most of the packages those devious chip designers can dream up. One of these tools was a very cheap, hand-held USB microscope.

Review by Andrew Levido

This was handy for inspecting joints or looking for solder bridges but it was not practical to use while soldering since the working distance (the distance between the work piece and the lens) was only around 20mm and there was a considerable lag in the video.

Thus, I tended to do most of my SMT work without magnification.



Viewing your work through the eyepieces then moving your soldering tool to the same place takes a bit of getting used to – but after a couple of hours, it does become second nature. The microscope is perfect for surface-mount devices.

Recently, after spending an afternoon hunched over the bench with my face only centimetres from a PCB, the crick in my neck told me something had to be done. I hit the 'net to see what the options were.

I steered away from video microscopes because I was wary of the video lag effect. I therefore narrowed my search down to optical stereo microscopes with a wide field of view and a good working distance.

Incidentally, I should point out the difference between a compound microscope (the type you might have used in science at school) and a stereo microscope. A compound microscope may have one or two eyepieces but has a single objective lens close to the object being examined. Often there are several objective lenses mounted on a turret but only one is in the optical path any time.

Compound microscopes offer high magnifications (up to 1600x) but the image is two-dimensional.

A stereo microscope, on the other hand, has two completely separate optical paths offering slightly different views, resulting in a three dimensional image. Magnification is usually lower than for compound microscopes (less than 100x).

What's available?

There is a wide variety of options out there, ranging from the top-of-the-line Mantis Elite at nearly $3,000 to low cost "toy" microscopes under $100.

After much searching I settled for a microscope from the US-based online retailer AmScope (**www.amscope.com**). They offer a truly bewildering array of microscope types and configurations. Ultimately I chose their SM-4TX-144A microscope package. See **www.amscope.com/sm-4tx-144a.html**

This is a *trinocular* microscope: as well as two eyepieces, it has a third optical port suitable for mounting a camera. It has a magnification ranging from 3.5x to 45x, continuously variable via a zoom knob, a wide field of view at 65mm and a working distance of 200mm.

It comes with a boom stand that allows the microscope to be moved in and out of the workspace and a LED ring light to illuminate the work surface. At about $US550 this seemed to be a very reasonable package.

I went onto the website and placed my order, only to discover the shipping would be around $US360, bringing the total to almost $1000 Aussie dollars – right at the top end of what I was prepared to spend.

Given that the package weighs over 30kg, there were no cheaper shipping options.

I swallowed hard, entered my credit card details, hit the go button and sat back to wait. But a few days later I got an email from AmScope explaining that they did not accept foreign credit cards, asking me to pay via their PayPal account.

No problem here but it seems an inefficient way to operate. They also stated: "all of our items come standard 110V, if you need 220V please let us know as there is a $5 fee for the upgrade". Again, no big issue – but the website could be a bit more friendly to overseas purchasers.

A few weeks later two parcels duly arrived, one containing the microscope head, the eye pieces, Barlow lens, eye guards, a plastic dust cover, the ring light and its control box. The second box (which I could barely lift) contained the parts for the boom stand. This is truly a massive (30kg) piece of hardware.

Caveat emptor!

By the way, there is an enormous price range for the AmScope SM-4TX-144A on the internet – and we're not sure why.

Some sources offer this microscope for about the same net price as AmScope or even less: after ordering (of

The eyepieces have a rubber shroud which can be extended, as shown here, or collapsed for those of us who are visually aided (ie, wear glasses!).

Included in the package is this ring LED worklight, absolutely essential for illuminating the subject, along with its power supply/controller. We have just a few reservations about the quality – but it works!

course!) we found one site selling for $US520 with $US53 shipping to Australia (~$AU600).

But there are others selling for *much* more (eg, >$AU1350 inc shipping) with no apparent "extras".

You can order this scope through amazon.com ("sold and shipped by AmScope") which suggests a $US499.98 ($AU537) including postage. But when you go through the cart process to order one, you're likely to find that they either "will not supply to your geographic area" or the "free postage" suddenly becomes not quite-so-free.

That same site adds a "per shipment" charge of $US29.00 and a "per weight" charge of $US8.99 per pound – and the AmScope website states a shipping weight of 68 pounds.

So that free postage could equate to $US611 or more than $AU650! So if you order on line, shop around, check the fine print and watch for any emails from the supplier.

In the end, I was happy that I ordered it from AmScope direct (and the security that provides) even if I did pay a premium.

Assembly . . . instructions?

The assembly instructions are pretty rudimentary and I found it easier to use a photograph from the website rather than the provided booklet to assemble the stand.

Otherwise, assembling the microscope head is fairly foolproof with the two eyepieces dropping in place and the Barlow lens screwing onto the objective lens at the bottom. The ring light is attached by three radial thumbscrews to a supplied collar that is screwed on to the Barlow lens.

Incidentally, the Barlow lens is used to increase the working distance at the expense of magnification. In the case of my microscope, the Barlow lens doubles the working distance and halves the magnification. If it is removed, the maximum magnification increase to 90x but the working distance is only 100mm.

The ring light is worthy of comment as it contains no less than 144 LEDs arranged in concentric rings. The controller allows the LEDs to be dimmed and also for separate control of each quadrant. This is handy if you want to light from one side only (for example to read those pesky black-on-black IC markings).

The ring light and its control box are shown above. Note the (mis)use of a USB connector and the US mains cable. The photo opposite shows two of the four segments illuminated.

One surprise was that my five-dollar "220V upgrade" consisted of an unapproved Chinese power adaptor so I could plug the supplied US-style 2-pin mains plug into an Aussie socket.

Pretty dumb really, since the mains cable connects to the light control box via a shaver-style cord. It would have been better (and safer) if they had simply packed an Australian cable.

The ring light control box is also a bit disappointing and has a bit of a home-made feel. It works fine but the buttons feel cheap and the ring light connector is a USB mini B type. I don't like the idea of using these connectors for non-USB purposes in commercial gear.

One day some "valued customer" will plug a USB device into the control box or the ring light into a USB device with ugly consequences.

The control box does have a CE mark label (although no US or Australian approval marks), so I assume it is reasonably well designed and made.

Using It

Apart from a bit of playing about, the first intensive use of the microscope was to construct the prototypes for the Audio Recorder published in the May and June 2014 issues of Silicon Chip.

This required five or six hours of intensive SMT work including soldering 0.5mm pitch TQFP microcontrollers and a 3mm x 3mm leadless pack, also with 0.5mm pitch.

Although it took a few minutes to get used to the idea of looking more or less straight ahead, while my hands were working down at bench level, I quickly became a complete convert to working with a microscope.

For most work, I kept the magnification quite modest, with the greatest benefit being improved posture and zero eyestrain. I think the consistency of my solder joints was also improved.

The microscope really came into its own when checking for solder bridges between pins or to check that a pin had properly reflowed.

By increasing the magnification, those tiny 0.25mm gaps between pins became yawning chasms and any soldering faults were rendered blindingly obvious. I was even able to tilt the microscope 45° to look at the edges of the leadless packages to see if the solder had reflowed properly.

As mentioned above, the ring light has plenty of modes but in practice I used it with all segments on and at close to full brightness almost all the time. The ring light is essential since without it the microscope image is almost unusable, despite my having a very bright lab.

I found the working distance to be completely adequate and never felt constrained by the presence of the microscope while using the soldering

Here's that same LED ringlight in action. It simply clips to the bottom of the Barlow lens (also supplied) and can be varied in brightness as well as in the segments illuminated. We tend to use it with all four on and flat out!

iron or any of my usual tools.

The field of view was also fine but there was an unusual side effect of viewing the work through what is effectively a 65mm diameter hole. I would tend not to lift my eyes from the eyepieces to grab the soldering iron, for example, and then fail to be able to bring it to the "hole".

The answer of course, is to only look through the microscope once your tools are nearly in position, but this took a little practice.

One other pleasing feature compared to the old USB microscope I used to use was the true three-dimensional nature of the image. You can really see the way the solder fillet runs up the end of a SMT capacitor, for example. The depth of field is adequate at about 5 or 6mm for typical levels of magnification.

Once you start using the microscope, you really begin to appreciate that heavy stand that cost so much to ship. The horizontal movement is very smooth and the solid construction and heavy counterweights mean that the microscope remains rock solid even at the fullest extension.

This means you can push the microscope right out of the way when you don't need it, but pull it into place in a couple of seconds.

I wear spectacles all the time and I was a little concerned how these would work with the eyepieces since I have had trouble with microscopes and telescopes before. I need not have worried, since the rubber eye guards (in their folded-down position) worked perfectly with my glasses. These eye guards also fold up for those lucky enough to have perfect vision.

Conclusion

On balance, the AmScope SM-4TX-144A is a great tool for anyone regularly using surface mount components – and that's most of us these days.

It is easy to use and will in all probability significantly improve the quality of the work you can do, and give you the ability to tackle the very fine pitch, leadless, and miniscule components that seem to be the norm these days.

I think that the manufacturer could easily do a little more to make things easier for non-US purchasers, by improving the website, fixing the "220V upgrade" and most importantly optimising the freight.

If I have a criticism it is the poor documentation and the barely adequate quality of the ring light power supply.

At around $1000 delivered, it is an investment on par with an entry-level oscilloscope or a top quality soldering station, so not one to be made lightly. Nevertheless, I am a complete convert, and would recommend a stereo microscope if you are doing a lot of SMT work.

For further information, go to the Amscope website at www.amscope.com SC

OCEAN CONTROLS

Helping to put you in Control

N480D PID Controller

Low-cost PID controller that accepts T/C & RTD input, 3 relay outputs & 1 pulse output for driving SSRs. Auto-tuning PID function, dual display & ramps soak function. 240 VAC powered.

SKU: CET-052 **Price:$79+GST**

Wireless Freezer Thermometer

FT0076 is an 8 channel wireless thermometer suitable for monitoring temperature of freezers. It has temp accuracy of ± 1 °C. Comes with 2 remotes & up to 8 sensors can be added, plus alarm configuration. 100 m transmission range. Batteries not included.

SKU: UTS-005 **Price:$85+GST**

Limit Switch

Roller adjustable lever type limit switch comes in a solid IP67 die cast cast with LED operation indicator. It is designed to for high mechanical intensity environments where it is exposed to heat, oil & dust. 24 VDC powered.

SKU: HNR-402
Price:$49.95+GST

Warning Red Light

Simple round cap, wall mount warning red light with PIR sensor that turns on light when motion is detected. It features 4 selectable melody tones that are rated to 90 dB. 24 VDC/AC powered.

SKU: HNL-101 **Price:$89.50+GST**

4 Channel Temp Logger

Serial port powered, temp data is output as a continuous data stream over an RS-232 serial port. Supports up to 4 x DS18S20 sensor, only 1 is included. PC software is provided for logging data to a CSV file.

SKU: KTA-145 **Price:$25+GST**

Ethernet Serial Server

Connects an RS-232, RS-422 or RS-485 serial signal to an ethernet network. 10/100 Mbps ethernet supported. SE5001 offers full-duplex and bi-directional data that is transmission transparent between the serial port and the Ethernet network. DE-9 serial port. 5 to 30 VDC powered.

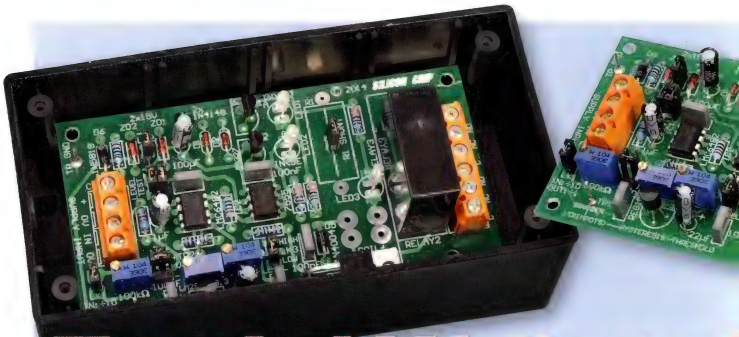
SKU: ATO-101 **Price:$129+GST**

GSM Wireless Home Alarm Kit

Home or office wireless alarm kit with base unit, wireless PIR and door sensor, strobe siren, 12 VDC plugpack and two keyfob remotes. GSM functions allow notifications to be sent to your mobile phone.

SKU: KPR-100 **Price:$249+GST**

For OEM/Wholesale prices
Contact Ocean Controls
Ph: (03) 9782 5882
oceancontrols.com.au



Threshold Voltage S

A simple but versatile device to switch a relay input voltage crosses a preset threshold

This versatile Threshold Voltage Switch takes the output of an analog sensor, battery voltage or other varying voltage and switches power to a fan, warning light or similar when a preset threshold voltage is reached. It can be set up for use with a 5V, 12V or 24V supply. It can also be used to prevent a lead-acid battery from being over-charged.

THIS IS a considerably enhanced version of the Voltage Switch project presented in our 2004 publication, "Performance Electronics for Cars". That has been a very popular project but feedback from readers over the intervening years has suggested a number of improvements which have now been incorporated.

When monitoring a sensor or any DC voltage signal, you may wish to switch power to a load on or off when a set voltage is reached. This means that at a particular temperature, pressure, fuel mixture or battery voltage, you can switch power to drive a cooling fan, a warning light, battery charging circuit or whatever you fancy.

Switching is done via a relay that can handle a relatively high current. The relay also provides isolation between the Threshold Voltage Switch sensing circuitry and the load it controls. So there is no requirement to power the Threshold Voltage Switch (TVS) from the same power supply as the load it controls.

It also does not matter where you put the relay contacts within the load circuit. So the relay can switch the positive or negative supply to the load, as depicted in Fig.1.

Fig.1A shows the load's ground connection being switched while Fig.1B shows the switch in the positive supply connection. Either way, the effect is the same but it may be more convenient or even a requirement to switch one or the other, depending on your application.

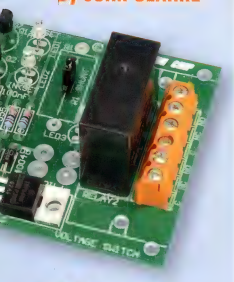
The relay can be switched on when the sensed voltage rises above a preset value or when it falls below the preset value. This is selected by links on the PCB.

Circuit description

Fig.2 shows the complete circuit for the Threshold Voltage Switch (TVS). It comprises two ICs, a 3-terminal regulator, the relay and a few other components.

Op amp IC1a is wired as voltage comparator to monitor the input (signal) voltage and compare it against a threshold voltage. The input voltage is fed via a 470kΩ resistor to pin 2, the

By JOHN CLARKE



witch

vhen an

Main Features

- Operates from 5-24V DC (nominal, 30V maximum)
- Adjustable trigger threshold
- Trigger on high or low voltage
- Output state indicator LEDs
- Multiple relay options, up to 60A SPDT or 10A DPDT

Specifications

Power Supply: 5-30V.

Current Drain: <1mA with indicator LEDs off (LK4 out), relay off and VR2 set to >100kΩ. With the relay on, the current is dependent on the coil resistance.

Signal Input Impedance: 470kΩ minimum.

Trigger Threshold: adjustable.

Input Divider: divide by 1 (LK1 out) or divide by greater than 5.7 (LK1 in).

Hysteresis For No Input Attenuation: ~5mV-2.5V for 5V supply; ~12mV-6V for 12V supply.

Hysteresis For 10:1 Input Attenuation: ~50mV minimum for 5V supply; ~120mV minimum for 12V supply.

Maximum Switching Voltage: 60V DC/40VAC for on-board relay; limited by contact ratings for off-board relay.

inverting input, while the threshold comparison voltage is fed to pin 3. If the required voltage threshold is above 3.3V, you will need to attenuate the input voltage and this is done by inserting link LK1. The amount of attenuation is then adjusted with multi-turn trimpot VR1.

A 3.3V reference voltage is provided by REG1, an LM2936 low quiescent current, low-dropout regulator which is fed from the V+ supply rail. It feeds trimpot VR3 and in turn, its wiper voltage is fed to IC1b which acts as a low impedance buffer to provide the reference voltage to pin 3 of IC1a.

Trimpot VR2 adjusts the hysteresis of comparator IC1a. Hysteresis can be regarded as positive feedback and it reduces the sensitivity of the comparator to short term variations in the input voltage.

To explain further, say the threshold voltage at pin 3 is 3V and the sensed voltage at pin 2 goes slightly above 3V, resulting in the comparator's output going low. The feedback connection from output pin 1 to pin 3 means that the voltage at pin 3 is pulled slightly lower than it was before pin 1 flicked low. That means that the sensed voltage at pin 2 will have to drop somewhat below 3V to cause the comparator to change state again. So the output will not switch again immediately if there is only a slight drop in the voltage at pin 2 immediately after the output switches.

Conversely, when IC1a's output goes high (near V+) in response to a dropping voltage at pin 2 of IC1a, pin 3 is instead pulled higher than before and pin 2 will have to rise by an increased amount to switch the comparator's output low again. So the threshold voltage for IC1a varies depending on the output of IC1a.

In practical terms, hysteresis prevents the relay from 'chattering' on and off when the sensed voltage is close to the voltage threshold. It also stops the circuit from switching on and off every few seconds. Say for example, you want a fan to cool a heatsink whenever the temperature reaches 60°C. As the temperature sensor reaches 60°C, the fan will run and almost immediately the temperature will drop by a small amount.

This means that, without hysteresis, the fan might run for a less than a second before switching off and then a second or so later, it will be on again as the 60°C threshold is reached. By adding hysteresis, the fan can be set to start running at 60°C but only switch off at say 55°C. That way, the fan will run for longer, preventing rapid on and off cycling.

When setting the threshold voltage for IC1a, we monitor test point TP2. This actually allows us to set the two switching thresholds: one when IC1a's output is high and the second when its

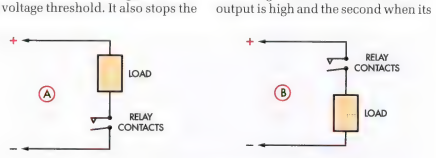


Fig.1: the relay can switch either the positive or negative supply lead to the load. Fig.1A shows the load's ground connection being switched while Fig.1B shows the relay contacts in the positive supply lead.

Parts List

1 double-sided PCB with plated-through holes, code 99106141, 107 x 61mm
1 UB3 plastic utility case, 130 x 68 x 44mm (optional)
1 12V DPDT relay (RELAY1) (Altronics 8A S4190D or low-profile S4270A, Jaycar 5A SY-4052)*
2 2-way PCB-mount screw terminals, 5.08mm spacing (CON1)
2 3-way PCB-mount screw terminals, 5.08mm spacing (CON2)#
2 8-pin DIL IC sockets (optional)
5 2-way SIL pin headers with 2.54mm pin spacings (LK1, LK2, LK4, LK5a & LK5b)
1 3-way SIL pin header with 2.54mm pin spacing (LK3)
6 jumper shunts (shorting blocks)
3 PC stakes (TP GND,TP1,TP2)
1 M3 x 6mm machine screw & nut

Semiconductors

1 LMC6482AIN dual CMOS op amp (IC1)
1 7555 CMOS timer (IC2)
1 BC337 NPN transistor (Q1)
1 BC327 PNP transistor (Q2)
1 IRF540 N-channel Mosfet (Q3)
1 LM2936-3.3 3.3V regulator (REG1) (Jaycar ZV1650)
2 1N4148 small signal diodes (D1,D2)
1 1N4004 1A diode (D3)
1 1N5819 Schottky diode (D4)
1 1N4744 15V zener diode (ZD1) (two required for 24V supply)
2 3mm red LEDs (LED1,LED2)
1 3mm green LEDs (LED3)
2 100kΩ 25-turn trimpots (VR1,VR3)
1 1MΩ 25-turn trimpot (VR2)

Capacitors

1 100µF 16V radial electrolytic
1 22µF 16V radial electrolytic
1 1µF 16V radial electrolytic
5 100nF MKT

Resistors (0.25W, 1%)

1 470kΩ
3 3.3kΩ (0.5W)
2 1kΩ
2 100Ω^
Plus R1 (5W) if required (see text)

Notes

* see text and Table 1 for other relay options.
# not required if an off-board relay is used; two PCB-mount vertical spade connectors plus matching crimp connectors are required instead.
^ For 5V supply, delete 1 x 100Ω resistor and add 1 x 10Ω; for 24V supply use 220Ω 0.5W.

output is low. The threshold measurement is made between test points TP2 and TP GND.

IC2, a CMOS 7555 timer, is used as an inverter and its pin 3 output goes to one side of 3-way header LK3. Depending on how link LK3 is set, the gate drive for Mosfet Q3 can come from either pin 1 of IC1a or pin 3 of IC2. This means that the relay can be turned on when the input voltage exceeds the threshold (LK3 set to HIGH) or when the input voltage goes below the threshold (LK3 to LOW).

As shown, the HIGH setting selects the output from IC2 while the low setting selects IC1a's output. The selected output then drives Mosfet Q3 via a 100Ω gate resistor. When Q3's gate goes high, Q3 turns on and powers the relay coil. LED3 (green) is also lit whenever Q3 is switched on.

Note that although Q3 isn't a logic-level Mosfet, it's suitable for use with a 5V supply which results in the Mosfet gate drive being less than 5V. We have specified an IRF540 Mosfet for this reason – it doesn't need to fully saturate as it's only switching a small current (the relay coil current).

Output indication

LED1 and LED2 are used to indicate IC2's output level and are selected by links LK5a & LK5b. They simply indicate whether the input signal is above or below the threshold voltage. LED1 is driven by NPN emitter-follower transistor Q1 while LED2 is driven by PNP emitter-follower Q2.

In operation, LED1 lights when the input is greater than the threshold, while LED2 lights when the input is less than the threshold. After setting up the threshold adjustments, the two LK5 jumper shunts can be removed so that these LEDs no longer light. This reduces the current drain of the circuit which can be useful in situations where current drain must be minimised.

Supply voltage

The circuit can be operated from supply voltages ranging from 5-30V. Most of the circuit is fed via Schottky diode D4 while the relay is directly powered from the input supply.

D4 is included for reverse polarity protection. It's followed by a 100Ω resistor (R2), while zener diode ZD1 is included to clamp the supply to 15V. ZD2 is used to drop the supply by 15V when a 24V supply is connected while LK2 is used to short ZD2 out if the supply voltage is below 15V. A 100µF electrolytic capacitor filters the resultant supply.

Note that the 100Ω resistor (R2) in series with D4 should be reduced to 10Ω if a 5V supply is used.

If the supply voltage is significantly more than the voltage rating of the relay, it will need a resistor in series with the coil. This is shown on the circuit as R1. As previously stated, the relay is driven by Mosfet Q3. If the voltage rating of the relay coil is close to the supply voltage, resistor R1 is omitted and link LK4 inserted instead.

Do not be concerned about the normal voltage variation which can be expected from 12V or 24V lead-acid batteries. A 12V battery may go as high as 14.8V while being charged while a 24V battery can go to 29.6V. Both 12V and 24V relays can cope with this variation and there is no need for a series dropping resistor.

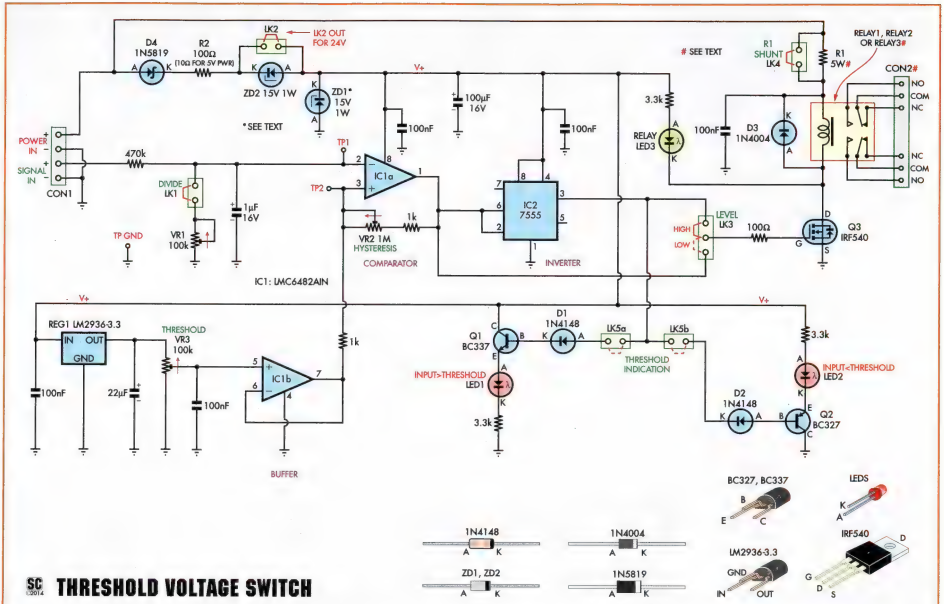
Diode D3 and its associated 100nF capacitor suppress the back-EMF transient when the relay switches off.

Construction

The Threshold Voltage Switch is built on a double-sided PCB coded 99106141 and measuring 107 x 61mm. This is designed to clip into the side channels of a plastic UB3 box (130 x 68 x 44mm), with the external leads exiting via a cable gland.

The UB3 box is optional, however. Depending on the application, it may be more convenient to house the PCB inside existing equipment.

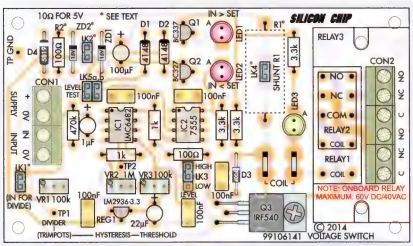
Fig.3 shows the parts layout on the PCB. Begin by inspecting the PCB for any defects (rare these days) and checking that the hole sizes for the larger parts are correct. If this checks out, the next step is to select the relay



SC 12014

THRESHOLD VOLTAGE SWITCH

Fig.2: the complete circuit of the Threshold Voltage Switch. Op amp IC1 is wired as a voltage comparator and this compares the input (signal) voltage fed in via CON1 with a threshold voltage set by REG1 & VR3 (and buffered by IC1b). IC2 operates as an inverter, while LK3 selects either the output from IC1a or IC2 to drive Mosfet Q3. Q3 is turn switches the relay. LED1 & LED2 provide threshold switching indication, while LED3 indicates when the relay is on.



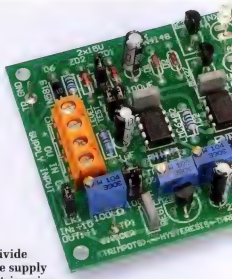


Fig.3: follow this diagram to build the TVS with an on-board relay. Install LK1 to divide the input signal, remove LK2 and install ZD2 for a 24V supply and install LK4 if the supply voltage doesn't exceed the relay rating (see text). LK3 selects high or low threshold triggering.

to be used from Table 3 (near the end of this article).

Choosing the relay

Basically, there are several different relays that can be used with the TVS. The overlay shows a standard 12V DPDT relay set up. It's just a matter of selecting a relay that suits your application.

Note that LK4 is fitted for most relays. However, if the supply voltage exceeds the voltage rating of the relay to be used, then LK4 is left out and 5W resistor R1 is fitted instead. R1 is wired in series with the relay coil to drop the voltage.

The value required for R1 is easily calculated. For example, if the relay coil is rated at half the supply voltage (eg, a 12V relay with a nominal 24V supply), then the resistor needs to have about the same resistance as the relay coil. In other cases, you can calculate the required value for R1 as follows:
(1) subtract the relay coil voltage from the power supply voltage and multiply the result by the coil resistance;
(2) divide the result obtained in step 1 by the relay coil voltage to obtain the resistor value required.

For example, to run a 12V relay with a coil resistance of 120Ω from an 18V supply, you will need a 60Ω 5W series resistor. This is calculated as ((18 - 12) x 120Ω) ÷ 12. If the calculated value is not a standard 5W resistor value, choose the next highest available value. **As stated earlier, for a 5V supply, resistor R2 must be 10Ω.**

Regulating the supply

By carefully choosing the values for ZD1 & ZD2, the supply for IC1 can be regulated. However, this is only required if the threshold voltage must have a very high precision, ie, the swing in the input voltage being monitored is below 100mV. The 3.3V reference is quite stable but it will vary by about 1mV for each 1V variation in the V+ rail.

Another reason for a regulated supply is that it makes for a more consistent hysteresis voltage.

For example, if a 12V lead-acid battery is used to power the TVS, the supply can vary from 11.5-14.8V. In that case, changing ZD1 to 10V will minimise any change in the threshold or hysteresis as the supply varies.

Similarly, for a 24V battery, both ZD1 and ZD2 can be 10V types. The point is to ensure that the supply voltage always exceeds the sum of the values of ZD1 and ZD2, but ZD1 must be between 5.1V and 15V. Resistor R2 can remain at 100Ω 0.5W for a 12V supply but should be changed to 220Ω 0.5W for a 24V supply.

Installing the parts

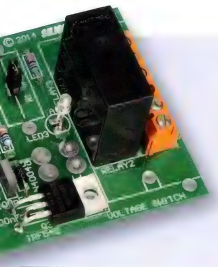
Once you've decided on the relay and supply regulation option, you can begin installing the parts on the PCB. The resistors, diodes and zener diodes can go in first. Table 1 shows the resistor colour codes but a digital multimeter should also be used to check each resistor before soldering it into place.

Make sure that the diodes and zener diodes are installed with the correct polarity, ie, with the striped end of each device orientated as shown on Fig.3. Note that ZD2 is not required if you intend using a supply of 12V or less (LK2 is fitted later instead).

The three PC stakes can go in next, one at TP GND and the others at TP1 & TP2. Follow these with Mosfet Q1 – it's mounted horizontally and secured to the PCB using an M3 x 6mm screw and nut. Bend its leads at right angles before mounting it into position and be sure to fasten its tab to the PCB before soldering the leads.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	3	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	2	100Ω	brown black brown brown	brown black black black brown



Maximum Switching Voltages For The TVS

Although its contacts may be rated higher, the maximum switching voltage for the on-board relay is 60V DC or 40VAC. **Do not try to switch mains voltages using an on-board relay, as the tracks on the PCB are too close together.**

If you do want to switch mains, you will need to use an off-board relay that has contacts rated for 230VAC. Many will be rated for 230VAC but those designed for automotive applications (eg, horn relays) will not be.

REG1, Q1 & Q2 are next on the list. Be sure to use the correct device at each location and note particularly that Q1 is a BC337 while Q2 is a BC327 (don't get them mixed up). IC1 & IC2 can then go in, again taking care not to get them mixed up and making sure that they are orientated as shown (ie, pin 1 at top left). They can either be soldered directly to the PCB or you can use IC sockets.

Now for the capacitors. The electrolytic types must be installed with the polarity shown (the longer lead being positive), while the MKT capacitors can be mounted either way around. Once these parts are in, you can fit the various pin headers for the jumper links.

LK1, LK2, LK4, LK5a & LK5b all require 2-way pin headers. Note that the LK4 header must not be installed if resistor R1 is to be fitted. 3-pin header LK3 should also be fitted now.

LEDs & trimpots

The three LEDs can be pushed all the way down onto the PCB or they can be mounted a few millimetres proud of the PCB. Make sure that each LED is orientated correctly, with its anode lead (the longer of the two) going to the pad marked 'A'. A cardboard spacer slid between the leads of each LED when soldering can be used to ensure consistent lead lengths.

Alternatively, if you want the LEDs to later protrude through the lid of the case, then it will be necessary to extend their leads and sleeve them in heatshrink tubing. You could also glue them to the lid and connect them to the PCB via flying leads; you could even fit pin headers in their place and use flying leads terminated in header plugs.

Trimpots VR1-VR3 are straightforward to install. Use the 1MΩ trimpot (code 105) for VR2 and be sure to install them with the adjusting screws to the left.

Now for the screw terminal blocks. CON1 consists of two 2-way terminal blocks and these must be dovetailed together before fitting them to the PCB. Push them all the way down onto the board and check that the wire entry holes are facing outwards before soldering the pins.

CON2 is required if you intend using a PCB-mounted relay. It consists of three 2-way (or two 3-way) terminal blocks and again check that it sits flush against the PCB and is orientated correctly before soldering the pins.

Alternatively, if an external relay with quick connectors it to be used, then the two 6.35mm PCB-mount male spade connectors will need to be installed. These are located just above Q3 and provide the relay coil connections.

Configuration

Once the PCB assembly has been completed, go back over your work and check it carefully. In particular, look for incorrectly orientated parts, parts in the wrong position and missed solder joints. If all is correct, follow this step-by-step procedure to configure the unit:

Step 1: if you are using a 12V or 5V supply, install the jumper shunt for LK2. Alternatively, for a 24V supply, install zener diode ZD2 and leave jumper shunt LK2 out.

Step 2: fit jumpers on LK5a and LK5b so that LED1 & LED2 will work.

Step 3: fit a jumper on LK4 if R1 has not been fitted.

Step 4: adjust trimpots VR1, VR2 & VR3 clockwise until the end stop clicks can be heard (note: these are 20-turn or 25-turn trimpots).

Step 5: apply power and check that voltage is present between pins 8 & 4 of IC1. The actual voltage will depend on the supply, zener diodes ZD1 and ZD2 and whether ZD2 is bypassed.

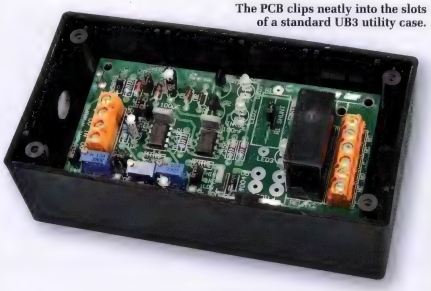
If you are using a 12V supply and a 15V zener for ZD1 (LK2 in), IC1 should have around 11.7V between pins 8 & 4. For a 5V supply, you should get a reading of about 4.7V. And for a 24V supply (ZD2 in and LK2 out), you should get a reading of about 8.7V.

Input signal level adjustment

LK1 can be installed to allow the input signal to be reduced if the voltage to be monitored is going to exceed 3.3V. To set VR1, apply a voltage similar to that you require for the threshold (say 10V) to the input, switch on and measure the voltage between TP1 and TPG. Adjust VR1 to obtain less than 3.3V at TP1.

Threshold adjustment

The threshold voltage adjustment is done as follows. Apply a voltage at the level you want the TVS to switch



The PCB clips neatly into the slots of a standard UB3 utility case.

Table 3: Relay Options For The TVS

TVS Supply Voltage:	5V (LK2 in)	12V (LK2 in)	24V (LK2 out, ZD2 installed**)
On-Board Relays (Maximum Switched Voltage = 60V DC or 40VAC)			
1A DPDT PCB Mount (RELAY2) Contact rating: 24V DC/40VAC	Altronics S 4147	Altronics S 4150	Altronics S 4152
5A DPDT PCB Mount (RELAY1) Contact rating: 30V DC/40VAC		Jaycar SY-4052	Jaycar SY-4053
8A DPDT PCB Mount (RELAY1) Contact rating: 30V DC/40VAC		Altronics S 4190D Altronics S 4270A	Altronics S 4195D Altronics S 4272
Off-Board Relays (Maximum Switched Voltage Limited By Relay Contacts)			
30A (RELAY3)* Contact rating: 14V DC/240VAC		Altronics S 4211 SPDT Jaycar SY-4040 SPST	Use 12V relay. R1=180Ω (for S 4211), 120Ω (for SY-4040) 5W, LK6 out
30A SPST Horn Relay* Contact rating: 14V DC		Altronics S 4335A Jaycar SY-4068	Altronics S 4332 Jaycar: Use 12V relay. R1=82Ω 5W, LK6 out
30A SPDT Horn Relay* Contact rating: 14V DC		Jaycar SY-4070	Use 12V relay. R1=82Ω 5W, LK6 out
60A SPDT Horn Relay* Contact rating: 14V DC		Altronics S 4339 Jaycar SY-4074	Use 12V relay. R1=82Ω 5W, LK6 out

Notes: LK6 installed (jumper in) unless stated.
* Bolt on and quick connector type. Requires 2 x 6.35mm PCB-mount male spade connectors with 5.08mm pin spacing (Altronics H 2094) plus 4 x 6.35mm insulated female spade quick connectors with 4-8mm wire diameter entry (these are not suitable for the 60A relay).
** Install 1N4744 15V zener ZD2.

A variety of relays can be used with this unit, such as DPDT (double-pole double-throw), SPDT (single-pole double-throw) and SPST (single-pole single-throw). Double-pole (DP) simply means that there are two separate sets of contacts that can be used independently to switch power (or even signals).

Single-throw (ST) and double-throw (DT) contacts each have a common (COM) contact and both ST and DT types have a contact that is open when the relay is off; ie, the normally open or NO contact. This NO contact closes against the COM terminal when the relay is on (ie, the coil is powered).

In relays with DT contacts there is also a normally closed (NC) contact. This connects to the COM terminal when the relay is off and opens when the relay is on.

Both SPDT and DPDT relays give the option of powering something when the relay is either switched on or is switched off. For example, you can set up the TVS so that power is switched on when the relay is off by connecting the load to its supply via the NC and COM contacts. The main reason to do this is to minimise the current drawn by the circuit. The TVS typically draws less than 1mA when the relay is off but when the relay is on, the current drawn by its coil will typically be around 50mA or up to 100mA, depending on the relay used.

Table 3 shows the various relays that can be used with the Threshold Voltage Switch. The choice depends on the supply voltage and the current to be switched by the relay's contacts.

PCB-mounting relays are accommodated on the PCB and their contacts brought out to screw terminal block CON2. By contrast, relays with quick connect terminals are mounted off the board. You can either use leads fitted with quick connectors or you can solder the leads directly to the terminals.

Since relays with 12V coils are more common than 24V relays, the TVS has been designed so that it can use a 12V relay even when operating from 24V. It's just a matter of removing LK4 and installing a dropping resistor (R1) on the PCB, in series with the relay's coil.

Having said that, if you are operating from a 24V supply and can obtain a suitable relay with a 24V coil and the correct pin-out, this will generally halve power and current consumption when the relay is energised. In that case, leave R1 out and install jumper LK4 instead.

the relay, then adjust VR3 until the threshold voltage is reached. LED1 will light when the input is above the threshold, while LED2 will light when the input is below the threshold.

With hysteresis trimpot VR2 set at maximum, the threshold for a rising input voltage will be similar to that of a falling input voltage. This hysteresis can be increased by reducing the value of VR2 (ie, turn VR2 anti-clockwise for more hysteresis).

Changing the hysteresis will also affect the threshold voltage previously set using VR3, so you will now need to readjust VR3 to correct this. Once that's done, check that the hysteresis set using VR2 is suitable and repeat the above steps if necessary.

Jumper LK3 determines whether the relay turns on or off for rising or falling threshold voltages. Install LK3 in the HIGH position if you want the relay to turn on when the input voltage exceeds the threshold. Conversely, install LK3 in the LOW position if you want the relay to turn on when the input voltage goes below the threshold.

Finally, to reduce the current drawn by the Threshold Voltage Switch with the relay off, jumpers LK5a & LK5b can be removed (to disable LED1 & LED2) once the set-up procedure has been completed. Alternatively, you may leave them in to monitor the unit's operation.

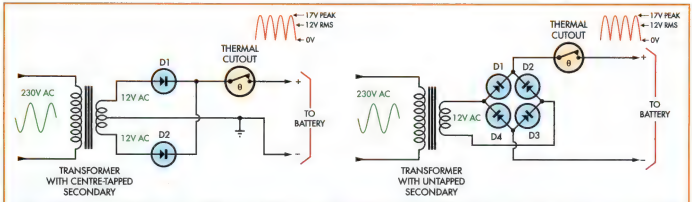


Fig.4: typical battery charger circuitry using either a centre-tapped transformer with two rectifier diodes (A) or a single winding transformer with a four-diode bridge rectifier (B).

Battery Charging With The Threshold Voltage Switch

MANY READERS have asked for a simple solution to prevent over-charging of lead-acid batteries. Most simple battery chargers do not have any end-of-charge detection and will continue charging at their full current even though the battery may have reached 14.4V. If allowed to continue for too long, such over-charging leads to severe gassing, excessive fluid loss as the battery overheats and even buckling of the plates. Ultimately, the battery will fail much sooner than it should.

Over-charging can also lead to a build-up of hydrogen gas in an enclosed space, which is an explosion hazard, especially in the presence of sparks (often caused if the battery is disconnected during charging).

An elegant solution to this problem is to use our Threshold Voltage Switch as a battery charge cut-off device and you can then add a trickle charge facility as well.

So why do most battery chargers not limit or stop charging when the battery reaches 14.4V (in the case of a 12V lead-acid battery)? The answer is that most chargers simply comprise a transformer and rectifier supplying raw full-wave rectified voltage to the battery.

Fig.4 shows two typical battery charger circuits. These use either a centre-tapped transformer with two rectifier diodes (A) or a single winding transformer with a four-diode bridge rectifier (B).

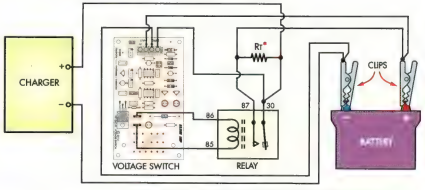
The charger will usually also include a temperature cut-out that switches the charger off when the transformer runs too hot. But there is no facility to sense the battery voltage or stop charging above a certain voltage.

You may have a commercial battery charger that uses a circuit like one of these or you may have built the Bits'n'Pieces Battery Charger from April & May 2013 SILICON CHIP. Either way, the charge process can be monitored to ensure that the battery isn't overcharged.

Overcharging can easily occur since these chargers use a nominal 12V (or higher) transformer. The output after rectification is pulsating DC with a peak voltage of around 17V. If the charger is left on charge for too long, the 17V peak can overcharge the battery easily, reaching well beyond 15V if left unattended.

This solution is the Threshold Voltage Switch. It can monitor the battery and switch off the charging current as soon as the voltage reaches 14.4V. Additionally, the hysteresis can be made sufficiently large so that charging does not recommence until battery voltage falls to its 12.6V (typical) resting voltage after charging ceases.

Fig.5 shows the required arrangement. The output from the charger



* OPTIONAL TRICKLE CHARGE RESISTOR (1W RECOMMENDED)

Fig.5: here's how to add the Threshold Voltage Switch to a battery charger, so that charging automatically ceases when the battery is fully charged. Resistor R_T is optional for trickle charging (see text).

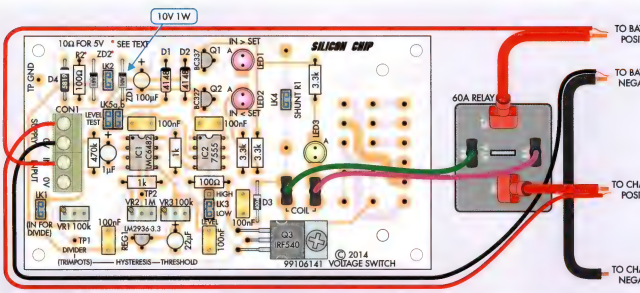


Fig.6: follow this diagram to assemble the PCB and wire it to an external relay and battery charging circuit. Medium-duty hook-up wire can be used for all connections to the PCB but be sure to use heavy duty cable for all connections between the charger and the battery and to the relay contacts (30 & 87).

is switched using a 60A 12V relay (Altronics S 4339 or Jaycar SY-4074). This heavy-duty relay is mounted externally, since it is too big to fit on the PCB.

It works like this: when the Common (COM) contacts are closed, the output from the charger is connected directly to the battery and the battery charges. As soon as the battery reaches 14.4V, the relay switches off and the contacts open, thereby disconnecting the battery to prevent overcharging.

The supply for the Threshold Voltage Switch is derived from the charger (rather than the battery), so that the battery doesn't begin to discharge when charging ceases. We do, however, monitor the battery voltage but this process results in a current drain of less than 32µA. That's much less than the battery self-discharge current.

Note that the wiring to the TVS for voltage sensing is run separately from the battery terminals. This ensures that voltage drop across the charging leads does not affect the measurement.

Adding trickle charging

Switching to trickle charging at the end of a full charge is a good idea, since it ensures that the battery is always fully charged (without the risk of overcharging). The trickle charge must be low enough to allow the battery voltage to drop to below or be held at 13.8V.

Typically, the trickle current should be 0.025% of the battery's Ah capacity, or about 10mA for a 40Ah battery. This can be achieved by adding a 220Ω resistor across the relay contacts.

The resistor value is calculated assuming a charging voltage of 15.8V (ie, 2V more than the 13.8V battery voltage). A 220Ω resistor will dissipate less than 0.25W but we recommend using a 1W resistor as it is more rugged and has thicker leads to make the connection to the relay terminals.

Fig.6 shows the PCB layout and external connections necessary to connect the TVS to the battery and the charger. The relay is mounted externally, with its coil terminated to the contacts on the PCB using spade quick connectors.

Note that Fig.6 shows the arrangement for charging a 12V battery. **Zener diode ZD1 is now a 10V 1W type (1N4740) instead of the original 15V zener and provides a regulated 10V supply for comparator IC1a.** This regulated supply is necessary because the hysteresis must be made quite wide and because supply variations would affect the voltage at which the TVS switches off charging.

For a 24V charger and battery, use another 10V 1W zener diode for ZD2 and leave LK2 open. In addition, the 100Ω resistor (R1) needs to be changed to 220Ω 0.25W. You will also need a relay with contacts rated for 28V DC.

Medium-duty hook-up wire can be used for all connections to the TVS but note that heavy duty cable must be used for all connections between the charger and the battery and for the connections to the relay contacts (30 & 87). We used 25A cable on our prototype but you could use 10A cable if the charger is a low-current type rated at less than 5A.

As shown in the photos, we installed the PCB and relay in a UB1 plastic utility case measuring 158 x 95 x 53mm. The PCB mounts on M3 x 9mm tapped stand-offs and is held in place using M3 x 6mm screws. The relay is bolted to the base of the case using an M4 x 12mm screw and an M4 nut.

Finally, the connections to the relay contacts are all made via quick connectors and the external leads are fed through a 10-14mm cable gland at one end of the case.

Setting up the TVS

The TVS must now be set up for battery charging following this step-by-step procedure:

Step 1: feed a voltage (eg, 9V) to the signal input on CON1, then accurately measure this voltage using a DMM (no need to apply power).

Step 2: connect the DMM between TP1 and TP GND, make sure LK1 is installed and adjust VR1 for a reading that's one-tenth the measured voltage in Step 1. This sets VR1 to divide by 10.

Step 3: measure the resistance between TP2 and the LOW position of LK3 (with the LK3 jumper out). Adjust

The PCB and relay for the battery charger cut-out version can be installed in a UB1 plastic utility case.

VR2 for a reading of 90kΩ to set the hysteresis appropriately.

Step 4: remove the input voltage, short the signal inputs on CON1 using a wire link and apply power to the circuit using the battery charger or a 12V supply.

Step 5: monitor the voltage between TP2 and TP GND and adjust trimpot VR3 for 1.44V. This sets the TVS to disconnect the battery from the charger when it reaches 14.4V. The hysteresis setting ensures that the TVS will not switch the relay back on again to reconnect the charger until the input voltage falls below 12.6V.

Step 6: remove the shorting link on the signal input and connect the signal "+" input to the positive supply rail instead. Now, with LK1 out, check the voltage between TP2 and TP GND; it should be close to 1.26V. TP2 should return to 1.44V if the signal input is again shorted to ground (ie, to 0V).

Step 7: install LK3 in the LOW position. LK5a & LK5b can either be removed or left in circuit to show the charging status.

In practice, leaving LED1 & LED2 operating is a good idea because the relay indicator LED3 now glows even when the relay is off. This is due to the supply coming from the pulsating DC of the charger plus various capacitive effects which cause the LED to light. By contrast, with a normal constant DC supply, the relay LED is extinguished when the relay turns off. SC

The external leads exit through a cable gland at one end of the case and the leads for the battery terminated in large alligator clamps. The two leads with the bared wire ends go to the battery charger.

Issues Getting Dog-Eared?

Keep your copies safe with these handy binders.

Order now from www.siliconchip.com.au/Shop/4 or call (02) 9939 3295 and quote your credit card number or mail the handy order form in this issue.
*See website for overseas prices.

Review by SILICON CHIP photographer, ROSS TESTER

Update: Eye-Fi goes mobile and cloud

Back in the October 2010 issue we told you about an exciting new development in digital photography and file transfer. In a standard-sized SD card, Eye-Fi combined both photo storage and a WiFi system, so you could move your photos to wherever you wanted without the card leaving your camera. Fast forward to 2014 and Eye-fi have made a few changes – not the least of which is that they now sell to Australia!

Think about that for a moment: not only was that SD card "standard" as far as storage was concerned but built into the SD case was a complete WiFi transceiver. Just goes to show how ultra-miniature these things have become these days!

(By the way, the SD card was bog-standard in size; it didn't need to be thicker or larger to accommodate the WiFi circuitry or antenna).

About our only criticism at the time was that, for reasons best known to themselves, Eye-Fi were not selling to Australia.

In fact, if you ordered a card on their website, it let you get all the way through the process (including entering your credit card details) then came back with a message saying that "they didn't sell to that geographic area". Curses!

Of course, we took this as a challenge and by using good ol' Señor Google, found an Eye-Fi reseller who somehow forgot about this restriction and posted our card to us – it only took a week or so from the US East Coast.

(Incidentally, since then Eye-Fi has emailed me and address me as a "valued user". Go figure!).

We used that card, very successfully, for the best part of

three years. Then, sadly (and not altogether unusually for SD cards), it broke. I couldn't access the 'storage' section of the card any more.

The WiFi section still worked perfectly but wasn't exactly useful, without the camera being able to store the pics! (Anyone know what to do with a perfectly good WiFi card that can't record anything?)

We tried the various SD card repair utilities and thought at one stage we had struck oil – except that the files were all corrupted! Repeating the process only proved how futile this approach was . . .

So for several months, we have reverted to the 'sneakernet' system we originally used – take the pics, take the card out of the camera, move it to a card reader on a computer and move the files manually.

Even this wasn't entirely successful: constant removal and replacement of the card destroyed one card (it fell apart) and even rendered the computer's card reader useless (it lost its ability to capture and hold the card itself).

Fortunately, the original Eye-Fi package included a USB SD Card Reader so we weren't completely stuck.

Side-by-side, it's not hard to tell the genuine from the fake. But would you remember the differences otherwise?

Cards go B-I-G!

The original Eye-Fi card was a rather massive (we thought!) 4GB. In 2010 terms, that *was* quite large. And the fact that we arranged our software so that the pics were deleted once sent to the computer meant that we never looked like filling it. Even a long day 'shoot' would be lucky to get to even a couple of hundred megabytes. So 4GB was way more than adequate.

But as you would no doubt realise, memory cards have made some staggering increases in size over the last few years.

I wrote in an article late last year that 128GB cards had become available and 256GB cards were in development – and a reader castigated me for spreading false information. "Anything over 32GB is almost certainly a fake," he said.

Perhaps then – but not any more: you can now buy a genuine 128GB Class 10 SanDisk Extreme PLUS SDXC card from SanDisk for just over $250. And I've seen 256GB SDXC cards advertised (not on ebay!) for less than $200.

However, our reader's warning still holds good on another point: many, probably the majority of very high capacity cards you buy on line (eg, on ebay) and more particularly out of China, will not only be fakes/forgeries, they will have a "spoof" utility built into them which fools you into believing they have that high capacity. At least that's what your computer reports.

There are all sorts of warnings on the net about these cards – one we read recently analysed a "128GB SDXC" card only to find it was actually a 1GB card with the spoof utility on it.

It's only when you shell out your hard-earned and try to record files that you find the truth.

One of two things will happen: (a) once you reach the *actual* card capacity, no more files will record, or (b) they appear to record perfectly but the files will be corrupted and unreadable. You've been warned!

By the way, if you want to avoid this nasty surprise, you're far better off buying locally and buying a known brand name. You'll pay a bit more but the risk of losing your valuable files is significantly lower.

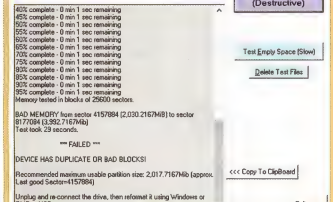
But even then, some people have been caught with a double-whammy: the "brand name" cards themselves are forgeries as well as spoofs. If you buy where you can take the card back, you could save yourself a lot of angst.

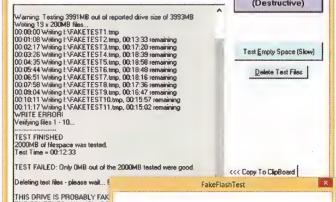
How do you check a fake?

We know this is a little off the track of our Eye-Fi card update but it's worth knowing anyway!

There are quite a number of utilities which will check the veracity of your card (or USB stick, etc) for you. One we use is "fakeflashtest.exe", a free download from **www.rmprepusb.com**

Just a word of warning: this is a destructive test – don't





Here's a couple of screen shots from fakeflashtest.exe – they're the images you really don't want to see. We were pretty sure the card was a fake, because it caused quite a few errors. Now we know for sure!

Cameras with Built-in WiFi

More and more digital cameras, especially (but not limited to) top-end models, are now being fitted with WiFi.

Naturally, this means that an Eye-Fi card (of any iteration) is not only not needed but may interfere with the inbuilt system.

This review is specifically intended for the (still!) huge numbers of cameras which don't offer WiFi, either native or as an option.

run it on a card with data you want (*especially* including even an "empty" Eye-Fi card because you'll destroy the essential Eye-Fi software recorded thereon!).

Are big cards really worth it?

While we're digressing, let's look at using big SD (or any other) cards.

If you're shooting lots of video, you'll need lots of storage capacity. So a large card is a convenient "gimmee".

But, as we mentioned before, memory cards fail. Either physically (eg, the card falls apart or the contacts break) or electrically (you can't read what's on the card or you can't write to it). We've experienced both.

In the latter case, there are rescue apps available but they may or may not work, depending on just what has caused the card failure.

OK, imagine you went on that extended world trip and had a few thousand photos on the card (and you do tend to take many more photos when they're digital!) when the worst happens – your card is corrupted.

Now you can see why it makes much more sense to use a few smaller cards than one big one.

Spread you pics out between several smaller cards – you'd be VERY unlucky to lose more than one.

Even a "small" card (small these days!) can hold a LOT of photos. Depending on camera resolution, an 8GB, for example, can hold at least 500-2,500 typical hi-res jpg shots (3-16MB each) while a 128GB can store between 8,000 and 40,000+.

Just to put that in perspective (and for the benefit of older readers who still "think" in 35mm film mode!), that atter figure is roughly equivalent to shooting a full roll of 36 exposures every day for more than three years!

But now there's an even better solution

We're back on track – talking about Eye-Fi!

As well as themselves significantly increasing their SD card capacity (their top card is now 32GB) Eye-Fi have now branched out into mobile devices. We'll explain that in detail shortly; in a nutshell it means your pictures can now be downloaded (via apps) to your Android or Apple phones, tablets, etc.

Eye-Fi X2 cards

We'll start with the "traditional" X2 WiFi memory cards of 4, 8 and 16GB formats – they're the ones we looked at back in 2010.

These SDHC cards (note that SD "HC" – the "high capacity" cards may not be backward-compatible with standard SD card readers) use your home or office WiFi setup to almost instantly transfer photos from your camera to a selected drive and/or folder on your chosen computer.

For example, here at SILICON CHIP we have a 500GB hard drive dedicated to storing the photos we take in our in-house photo studio. When we set this up a few years ago, we thought 500GB would last us for an eternity.

We've now proven that eternities last about two years!

The Eye-Fi card doesn't discriminate: it sends every picture we take, including oopses and blanks (hey, it happens!) to the hard drive. We've arranged it so that the pics go into a folder with that day's date as the file name.

Later we select the ones which are going to be kept in perpetuity and move them into folders more relevant to the subject being shot. We also deleted the mis-shot pics to save disk space.

Moving the pics from camera to hard drive is a totally seamless process – the only thing that we have to remember is to leave the Nikon turned on so the Eye-Fi card can continue its magic (it's second nature to turn the camera off when the studio flashes are turned off . . .)

For a more detailed explanation of this process, we refer readers back to that October 2010 article (copies available via our website).

But as we said at the outset, Eye-Fi have been busy little bees and have come up with Eye-Fi mobi.

Eye-Fi mobi

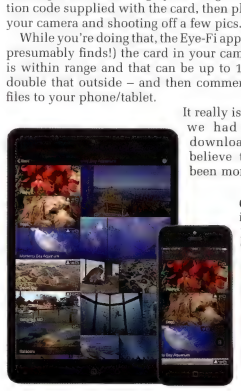
Eye-Fi mobi is different to the X2 type in that it is specifically intended to operate from camera to mobile device, whether that is a phone or tablet computer.

Don't be fooled by the word +WiFi on the front of the card; it won't work with your home or office WiFi. (You might have noted that it doesn't have the usual WiFi logo).

It operates with Android and iPad devices. The specifications we read said that it required Android 2.3 – our Android 4.0 tablet had no problems whatsoever. If you own a Windows tablet, at the moment you are out of luck (but that may come in the future).

Using it is as simple as downloading the Eye-Fi mobi app (either from Eye-Fi or from the App Store/Play Store), running it and activating by entering the ten-digit activation code supplied with the card, then placing the card in your camera and shooting off a few pics.

While you're doing that, the Eye-Fi app searches for (and presumably finds!) the card in your camera, as long as it is within range and that can be up to 14m or so inside, double that outside – and then commences copying the files to your phone/tablet.



It really is that easy! While we had a few dramas downloading the app I believe that might have been more to do with the

Once the app is loaded, the photos taken on your Eye-Fi equipped camera are downloaded to your Android or iOS device automatically if it's within range, You can review and edit them as you wish.

Eye-Fi Mobi specifications

Wi-Fi Range: Outdoors – 27.5m, Indoors – 14m
Wi-Fi transfer image support: JPEG
Wi-Fi transfer video support (under 2GB per file): .mpg, .mov, .flv, .wmv, .avi, .mp4, .mts, .m4v, .3gp
Security standards: Improved WPA2-PSK plus static WEP 64/128 and WPA-PSK)
Size: 8GB, 16GB or 32GB SDHC Memory, depending on model
Speed: Class 10 SDHC performance
Read/Write support: All file types, Including RAW*
Power: Advanced power management optimises use of camera battery
* RAW files cannot be uploaded via Eye-Fi.

el-cheapo Android tablet I was using. Later I'll give it a go with my partner's shiny new Samsung Galaxy and I'm pretty sure it will behave itself perfectly.

I didn't try loading it on an iPad so cannot comment on the process there – but I have every confidence that it would be just as easy.

Incidentally, if you have more than one camera and wish to purchase extra Eye-Fi mobi cards for each one, you can have up to ten cards/cameras synched to the one mobile device.

Conclusion

There is no doubt that Eye-Fi cards cost a *lot* more than an equivalent "naked" SD card. You can easily buy a Class 10 16GB Sandisk Utra card for less than $15.00 (rule-of-thumb these days seems to be about a buck a [giga]byte).

But that's like saying you can buy a camera without a lens for a lot less than one with: nice to look at but not real useful!

Here you're buying functionality and convenience. It's nice to have that huge storage on the card but you're buying what the other part of the card can do for you – seamlessly transfer the data. So that 'extra' you pay over the standard SD card really doesn't come into it.

The mobi Eye-Fi card does what it does with a minimum of fuss and a minimum of setup. If you want the extra functionality of the older, "X2" WiFi card, you're going to have to pay extra for it – and take longer in getting it going.

The old "horses for courses" adage really comes into it: if you want to be able to transfer pics from camera to mobile device (and hopefully, before too long, to the cloud), the mobi is the one to go for. If you want to use your home or office WiFi setup, the X2 is for you. SC

Where from, how much

Eye-Fi cards are now available from a number of photographic retailers in Australia at comparable prices to (and in some cases even better than) those you pay on the web, direct from Eye-Fi.

For example, the Mobi 16GB eyefi card from Eye-Fi (www.eyefi.com/buy-now) is $AU89.99 with "free" P&P but is available for $74.00, inc GST, from www.camerastore.com.au. However, we've seen it for more than $100 – for the same thing – at other stores.

So shop around!

Eye-Fi's online prices for their Mobi other models are currently $AU59.99 for the Mobi 8GB and $AU112.99 for the Mobi 32GB. These prices include free standard P&P (prices as at June 2014).

The Convenient All-in-One Solution
for Custom-Designed Front Panels & Enclosures

You design it to your specifications using our FREE CAD software, Front Panel Designer

We machine it and ship to you a professionally finished product, no minimum quantity required

- Cost effective prototypes and production runs with no setup charges
- Powder-coated and anodized finishes in various colors
- Select from aluminum, acrylic or provide your own material
- Standard lead time in 5 days or express manufacturing in 3 or 1 days

FRONT PANEL EXPRESS
FrontPanelExpress.com
1(800)FPE-9060

Remote Control Made Really Easy

The KSRC2 UHF set controls appliances, lighting, scoreboards & models over 40metres. Its two independent receiver relay outputs are rated to 500Watts
Special S.C Project Offer!!!
$22.30 inc. GST Plus $7.50 P & P

Digital Panel Meters at Analogue Prices

KSDVM-30 ULTRA-COMPACT
4.5-30VDC Digital Panel Meter
Features: Bright 0.36" Red LED Digits. Snap-Fit Housing. Range optimized for solar, automotive and trucking applications.

$6.70 inc GST Plus $4.50 P &

MXA026 Stop-Watch & Clock

Six, daylight-visible 60mm Digits
Timing Down to 100th sec.
Battery Back-up circuit
Really easy to use and install.
Special Low Price $93.70 inc. GST
plus $11.50 post and Pack

KitStop electronics – the fun starts here
www.kitstop.com.au
P.O. Box 5422 Clayton Vic.3168
Tel:0432 502 755

SERVICEMAN'S LOG

Oh goodie – a valve radio to fix!

Dave Thompson*

Fixing valve radios can be a real challenge, particularly if you don't have a circuit diagram. That was certainly the case with an old Philco valve radio I took on recently as a favour for a friend but luck was on my side.

Mention valve technology to today's servicemen and you'll get a variety of responses, usually ranging from a disbelieving chuckle to a snort of derision. In rare cases, there's a knowing nod and a smile.

Surprisingly though, while talk of valves may conjure up memories of grandma's old Gloria or AWA radiogram, valves (or vacuum tubes as the Americans call them) are used more widely these days than you might think. For example, next time you go to a rock concert, check out the stage; chances are that many of the amplifiers will be "valve powered". Guitarists particularly love valve amplifiers and for good reason; they just sound better.

Of course, sound is subjective and that's a bold statement for me to make. However, it's generally accepted that valve guitar and bass amplifiers give a much warmer tone than their transistorised counterparts. In my experience, that has certainly been the case, though ironically my current amplifier is a solid-state model that's been specially designed to emulate the signature tones of well-known guitarists, most of whom use valve units.

Another area where valve amplifiers are sometimes found is in esoteric home stereo systems. Often, this type of set-up involves at least two separate valve amplifiers (one for each channel) and sometimes a stand-alone bass amplifier driving a subwoofer. Those who own such systems have usually had to part with large sums of money for the hardware. And while they are undoubtedly beautiful to behold (both visually and aurally) most people just shake their head in bemusement and argue that a cheaper solid-state amplifier will do the job just as well, if not better.

It's also interesting to note that the valve mixing consoles used in the world's famous recording studios are now highly sought-after. Those replaced with more modern consoles were usually snapped up by engineers or others who just happened to be in the right place at the right time. The owner of the original valve console from Abbey Road studios, for example, could have just about named his price and got it. All consoles impart their own unique sound characteristics to the finished product and, in the case of the Abbey Road console, it's difficult to put a value on the history.

There are several characteristics inherent in almost all types of valve-based gear. First of all, valves are fragile and prone to failure if not looked after properly. Second, the components used in valve amplifiers are typically more robust and heavier than those used in equivalent solid-sate devices. This means that all associated circuit boards and even the cases must be strong enough to handle the extra weight.

Finally, valves generate a lot of heat and this usually means that cases must be well-ventilated. Of course, solid-state amplifiers can also generate a lot of heat but that can usually be taken care of by attaching the output devices to heatsinks.

VALVES GENERATE A LOT OF HEAT...

Items Covered This Month

- Philco valve radio
- Lightning strikes again
- Ebara sump pump
- Surge Catcher power board
- LED torch repair
- The things some customers do

*Dave Thompson runs PC Anytime in Christchurch, NZ.
Website: www.pcanytime.co.nz
Email: dave@pcanytime.co.nz

A valve radio to fix

So what's all this leading up to? Well, just recently a friend of mine asked if I knew anyone who could take a look at a Philco valve radio that he'd been bequeathed. Many years ago, as a young boy, he often sat and listened to this radio when it took pride of place on the mantel in the lounge-room at his grandparents' house. At the time, he was fascinated with the stations listed on the dial and the exotic locations some of them represented.

Like me with my parents' old valve radio, he spent ages messing with the tuning to see if he really could get Radio Luxembourg (he couldn't and neither could I). As an aside, the large radiogram in my parents' lounge-room boasted a fascinating device called a

"magic eye". This was a special type of valve that was used as a tuning indicator. As a station was tuned in, an internal glow area in the "magic eye" valve changed shape, allowing the tuning to be accurately set.

My friend's radio didn't have a magic eye but it did have a large back-lit tuning dial listing both local and (ambitiously) overseas stations. Unfortunately, turning the set's on/off switch to ON resulted in a big fat nothing, so something was very wrong.

Not knowing anyone who serviced valve radios, I said that I would take a look at it. What I like about this older analog electronic circuitry is the point-to-point nature of the wiring and the fact that everything is on show. I also like the electromechanical aspect of these old radios, with their dial-cords, dial pulleys and open-ganged tuning capacitors.

By contrast, much of today's electronics is often purposely obscured and in some cases potted so that nothing can be seen at all. While some of this is to protect commercially-sensitive information, I also occasionally get the feeling that the workings are hidden away so that we don't see just how simple the circuitry really is and thus whinge about how much we've paid for the item.

I've experienced this in my own workshop. Many people who've never seen the inside of their computer are stunned when they finally realise just what is in there. In fact, I sometimes get the impression that they feel ripped off because the case isn't full to the brim with hardware and flashing lights.

Is it getting power?

Getting back to the radio, I initially decided to check the power supply and see just what was powering up. I am always cautious when playing around with mains-powered valve radios; some have a 'hot' chassis, which means that the metalwork is running at mains potential and that makes me very nervous. Fortunately, this particular model wasn't one of those but it still had 230VAC wiring in there, with many connections exposed to wayward fingers. As a result, I took extreme care while poking around inside it.

One thing I noticed was something I'd read about in the Vintage Radio section of SILICON CHIP; the mains cable had at some point been changed to a more modern type, along with some of the associated components. There were a few fairly modern capacitors and resistors in among the original parts, so someone had repaired this set at some time in the past.

From what I can gather, this is a very common modification for vintage radios. Capacitors dry out over time and their values change, causing all sorts of problems. Similarly old resistors heat up and cool down one too many times and can go open circuit or change value, causing things to stop working properly. So, if the radio is to be used, it is common for these components to be replaced with their modern equivalents, providing both increased safety and reliability.

Because this radio had already been overhauled, I wouldn't have to touch these parts, unless of course one of the new parts was the cause of the problem.

The first place to start was the on/off switch itself. As in many of these radios, the power switch is part of the volume control and physically sits on the back of the potentiometer. First, I made sure that the set's power cord was out of the wall socket. A quick check with my trusty multimeter on the continuity setting then confirmed that the switch was operating as expected. It's always a good idea to check the obvious up front, as it can save you a lot of time and grief.

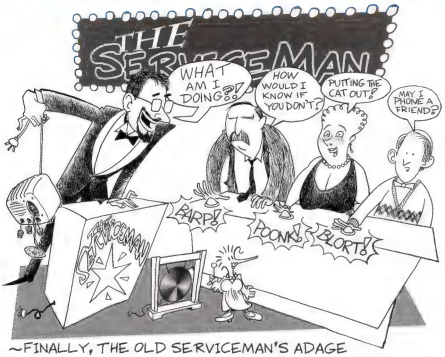
The power supply circuitry came next and this is where one has to be careful; 230VAC hurts! I plugged the radio in, switched it on and set my meter to the auto DC voltage range. At this stage, all I could do without a circuit was to confirm that there was power at random points around the chassis. I could that see the valve heaters were glowing so they were obviously getting power and by carefully poking about at the bottom of the sockets, I was able to measure various DC voltages. Unfortunately though, I had no idea what any of these readings were supposed to be but the fact that I was getting something led me to believe that the power supply was working (though just how well I had yet to discover).

When working on devices I don't know much about, most of my troubleshooting is based on circumstantial evidence. In particular, I look for bad solder joints, wires that may have come adrift and any other obvious problems. For example, if I hadn't been able to measure any voltages around the chassis, then that would have pointed to a power supply issue, even without me knowing exactly what made up the power supply or how it worked.

Of course, determining the source of a problem is one thing; finding the exact cause and fixing it is another, especially without a circuit or prior experience with this type of set!

No speaker thumps

One thing I noticed from the beginning (but being thick it didn't really dawn on me for a while) was that when I switched the radio on or off, I didn't get any sound at all from the speaker. I seemed to remember from playing with other old radios that there was usually a 'thump' from the speaker every time the set was turned on or



off. Of course, this isn't a hard and fast rule but I expected something audible.

I also noted that there was no background hiss or crackling as one would expect when operating an old volume control potentiometer, even approaching full volume. So it appeared that the problem lay in the audio or output stages, so that's where I looked next.

After switching the radio off and leaving it for a minute or two, I checked the speaker's voice coil. It measured around 600Ω which seemed an odd figure, though once again I had no idea what it should be. There was also what I assumed to be an output transformer mounted on the speaker's frame so I checked that as well but couldn't get any continuity or resistance reading at all on its primary side.

By now, I was hoping that this area wasn't the problem because I had no way of knowing what the correct values for these components would be. A quick Google search then informed me that the output transformer might not be an output transformer after all. Instead, it might be a field coil, which is quite a different animal.

And that was that; I hate being stymied but without a circuit or advice from someone who knew what they are talking about, I'd come to a dead-end, with no real way of moving forward with this repair.

After some fruitless reading on various internet forums, I suddenly recalled that one of my computer clients dabbled in antiques. In fact, I'd visited his workshop on a call-out some time back and had noticed some old radios he had sitting on a shelf. I quickly found his number and gave him a call and he said that he would be more than happy to show me his (now much larger) collection.

While he wasn't into electronics and didn't repair the electrical parts of these radios, he made a beautiful job of repairing the cabinets and restoring the exteriors. Because of this, he mainly collected radios with timber cabinets but he did have a few Bakelite and early plastic models, all in varying degrees of restoration.

I was particularly interested in a box of parts he mentioned, which apparently included some speakers. I'd taken along the speaker from 'my' radio and after politely listening to his restoration stories, steered the conversation towards a possible replacement from his as-yet-unseen box of parts.

His 'parts box' turned out to be quite a large collection of old chassis, reclaimed valves, knobs, dial mechanisms and other bits and pieces he'd collected over the years. If he was given a non-working radio and it was unlikely to ever run again, he stripped it down and the parts ended up here.

What interested me was that he had quite an assortment of speakers in varying stages of serviceability; some looked OK, some had torn or missing cones and some were intact but had suspect electricals. But regardless of condition, they were all were marked with a sticker containing the date acquired, any relevant values and known condition.

I showed him the speaker I'd brought along and he rummaged around before pulling out what he claimed would be a suitable replacement. It wasn't round, as mine was, but rectangular, though he assured me that with minor modifications it would fit in the cabinet and could be connected to the four existing leads without problems. All I had to do was make sure the right leads went to the right places.

He even offered to replace it with another one if this one didn't work. I offered to pay him for it but he wouldn't hear of it, so I told him that the next time I did any computer work for him I'd return the favour.

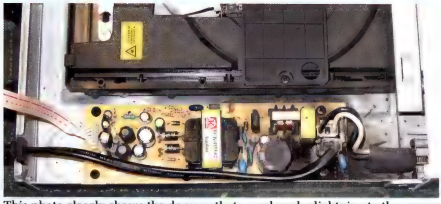
The smell of old solder

Once I got home, I immediately began connecting the replacement speaker and as I tinned the wires and speaker terminals, memories came flooding back. For me there's something about the smell of that old solder they used back in the day; it brought back fond memories of learning to solder, with Dad keeping a constructive yet critical eye on what I was doing.

These days, the PC-mad health and safety brigade would have a fit over the smoke and fumes given off by those old flux-filled solders. In my case though, I'll always associate that smell with nights spent out in Dad's workshop as he taught me to solder.

As for the speaker, I didn't bother retrofitting it into the case until I knew it was going to work. However, I could tell we were good to go as soon as I plugged everything in and switched the radio on. Immediately, there was a reassuring "click" from the speaker as power was applied and after the requisite warm-up period, static and hiss could be heard. A quick tweak of the tuning dial then brought in a local AM station loud and clear.

Struck By Lightning . . . But The VCR Still Worked!



This photo clearly shows the damage that was done by lightning to the power supply in this DVD player. Note the blackend areas on the PCB and chassis near the incoming mains connections are bottom right.

Another photo inside the damaged DVD player, this time with the power supply PCB removed. A hole has been burnt right through the metal chassis (bottom right) by the lightning strike.

Lightning can cause a lot of damage to electronic equipment as S. G. of Mildura knows only too well. This story graphically illustrates what can happen . . .

Some time ago, the Mildura area was hit by a severe thunderstorm that did a fair amount of damage. The next day, our phones rang hot with customers complaining about lost TV reception and/or other faults.

In one case, I was sent to a customer's home-unit to check why the TV was no longer working. When I arrived, the lady led me into the lounge room to show me the offending set, a Panasonic 51cm colour TV in a plastic cabinet. A Panasonic VCR was stacked on top of this cabinet, with a DVD player then stacked on top of the VCR and then a digital set-top box on top of that.

All were as dead as a dodo, with not even the standby indicator LEDs coming on.

In addition, the customer had another TV and set-top box in the main bedroom and another similar set-up in the kitchen. All were dead.

The digital clock in the wall oven had also failed and the only thing I could do was to pick up all the gear and take it back to the workshop for further investigation.

As shown in the accompanying photos, there was a lot of damage to the set-top box, DVD player and the VCR. Clearly, they had suffered a lightning strike and they, along with the TV sets and the rest of the equipment that the home-owner had, were write-offs and were replaced by the owner's insurance company.

A new TV antenna was also required, along with a complete rewire to the three outlets using a new splitter and wall outlets. Our third-year apprentice eventually did all that work and he told me that the centre wire of the original coax was "missing".

The customer had also lost her telephone service and both her phone and a timer for the watering system had been damaged and required replacement. However, her fridge and dishwasher had survived.

A hole had been burnt through the lid of the customer's Panasonic VCR but amazingly, the unit still worked.

Other neighbours in the same unit complex didn't have as many problems, so my customer certainly copped the worst of the strike.

Several months later, I was having a bit of a clean out and came across the damaged Panasonic VCR that I thought that had "gone to God" during the storm. My curiosity aroused, I took a much closer look at it and the only damage that I could see was a bad burn mark on the top of the lid. The inside of the unit appeared to be OK and so after checking the power supply for shorts, I decided to power the unit up and see what happened.

As a precaution, I stood well away from the bench and pressed the power switch using a broom handle. It was all an anti-climax – the only thing that happened was that the display lit up and started to flash (because the clock hadn't been set).

Encouraged by this, I loaded a tape and pressed the play button. Well, you could have knocked me over with a feather – despite getting a real boot from the lightning strike, the VCR playback function still worked. What's more, using the remote control, I was able to tune in the pattern generator that's used to inject a signal into our antenna system in the shop. That proved that the UHF section of the tuner still worked, which probably meant that the VHF section was also still working.

So why did the VCR's circuitry survive, despite the damage to its case? Well, its owner used it only to play back pre-recorded tapes and so it hadn't been hooked up to the antenna system which had apparently taken part of the lightning strike.

Thank goodness there wasn't anything seriously wrong with this set because without a circuit diagram I would have struggled to get it going again. Fortunately, changing a speaker or finding a loose wire or dry joint is something anyone with basic technical skills can do.

Finally, the old serviceman's adage that "if you don't know what you are doing, find someone who does" really hit home on this repair. If not for my vintage radio enthusiast friend and his collection of spare parts, I might still be looking for a new speaker for the old Philco.

Ebara sump pump

Regular contributor B. P. of Dundathu, Qld recently solved a problem with a sump pump that packed it in on his property. Here's how he got it pumping again . . .

A sump pump is a small, self-contained unit with a float switch and, as its name implies, is used to pump water from a sump, pit or tank. These pumps generally don't require any attention; they automatically switch on when the water rises to a certain height and then switch off again after the water level falls.

We use this type of pump in our waste-water tanks and as well as the units in service, I also have three pumps which I keep as spares. Two of these were repaired after they had previously failed and been replaced, while the other was acquired at a junk sale and repaired.

A few months ago, I used my spare Grundfos pump to transfer water from one of our dams but then the next time I went to use it, it wouldn't work so I fetched my spare Ebara pump and used it instead. It worked fine but the next time I went to use this pump again, it wouldn't work either and I was forced to use my last remaining spare to do the job on hand.

Later on, I decided to check out the Ebara pump to determine why it had suddenly stopped working and to see if I could repair it. The first step was to power it up and see what happened. When I did this, it just buzzed and didn't run. I immediately suspected a jammed impeller, which sometimes happens with these pumps, so I unplugged the unit and set about checking it.

I began by removing the strainer which is held on by two screws. I then spun the impeller by hand and it turned freely, thus eliminating trapped debris as the cause of the problem. I then spun the impeller by hand again and quickly hit the power and this time the pump sprang to life. And that indicated a faulty motor-start capacitor.

These pumps use a squirrel-cage induction motor and a motor-start capacitor to initially 'boot' the rotor into motion. When the capacitor fails, there is nothing to kick-start the rotor, so this was the most likely cause of the fault with this pump.

I then set about further dismantling the pump. After removing the lower cover which was held on by three screws, I removed the impeller by undoing a single nut. I then removed the three screws that held the lower plastic section onto the stainless steel body and attempted to separate the two sections. However, this proved quite difficult, as they did not want to come apart.

Bearing in mind that I had to be very careful not to break the rigid plastic section, I gently prised around the edges until I finally got the two pieces to separate. This then let me slide the workings of the pump out of the outer shell.

I was then able to remove the black plastic 'cap' from the top of the main stainless steel body of the motor. And this revealed the cause of the problem – the motor-start capacitor had indeed failed, its insides partly escaping through the plastic can. I'd previously seen this type of capacitor failure in washing machines and dryers but I hadn't expected to see anything like this in a sump pump.

I checked my stock and I found that I didn't have the correct value capacitor on hand; I needed an 8µF unit but the lowest value I had was 10µF. This meant that I had to obtain a capacitor but first I thought I'd check out the rest of the pump, to see if it needed any other parts. That way I could do a complete refurbishment while the pump was apart, if necessary.

I spun the motor shaft by hand and I could hear that one of the bearings was quite noisy, so I decided to replace it. That meant removing the stainless steel motor body from the black plastic section.

After undoing the four screws holding the parts together, I tried to separate them but it was as if they were glued together. Eventually, after some gentle prising and tapping, I finally got them apart and I was then able to determine that it was the bearing closest to the impeller that was faulty.

Removing the bearing from the plastic housing was rather difficult, as the plastic housing had a steel retainer pressed onto it and punched, to prevent it from coming off. This made it necessary to drill out the punchings, after which I was able to prise the retainer away and press the bearing out.

At this stage, I also decided to replace the two seals, even though they hadn't been leaking. However, they had definitely lost some of their elasticity and I reasoned that they were getting towards the end of their lives. It was important to replace them to ensure that no water entered the motor. As an aside, some sump pumps have the stator coils fully sealed and oil-cooled but this particular pump has a conventional air-cooled stator.

I needed to go into town the following day, so I sourced the bearing and the two seals locally. These parts were readily available for a reasonable price but not so a replacement capacitor which I eventually ordered on eBay.

When the capacitor arrived, I soldered and heatshrinked the wires to it. I then reassembled the pump in

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in The Serviceman column in SILICON CHIP? If so, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics.

We pay for all contributions published but please note that your material must be original. Send your contribution by email to: editor@siliconchip.com.au

Please be sure to include your full name and address details.

reverse order of disassembly. This was relatively straightforward as there aren't a lot of parts and it was fairly easy to see how it all fitted together.

There are four O-rings in this pump, two of which keep the electrics sealed from the surrounding water. The other two seal the pump chamber. I inspected each of these O-rings and I found them all to be in good order, so I didn't replace any of them. However, I did give each one and their associated grooves a good coating of marine grease before reassembly.

This assists the reassembly process by ensuring that the parts slide into place easily and it also helps ensure that the O-rings seal correctly. The new seals were greased as well.

Once the pump was completely together, I connected it to power and lifted the float switch to check that it was working correctly. The pump quickly spun up, so I lowered the float switch to allow it to stop again.

The next step was to immerse the pump in a bucket of water for a quick test of its pumping ability. I repeated the above procedure and when I lifted the float switch, the pump immediately burst into life and sprayed water into the air. I then released the float switch and the pump stopped, so it was all working correctly.

Excluding labour, the total cost of repairing this sump pump was just under $25. It's interesting to note that the same type of pump is still available new and currently retails for around $290. So, for less than 10% of the cost of replacement, I was able to return this non-functional unit back to full working order again.

Finally, about the only other thing that can go wrong with these pumps in normal use is failure of the float switch. After considerable use, the wire inside the cable to the float switch can break but float switches are available for around $40, so that repair would also be well worth the effort if required.

DSE Surge Catcher Power Board

Another job I recently took on involved a DSE Surge Catcher 6-way power board that I'd been given some time ago. This is quite a fancy unit with six mains outlets plus phone/ADSL sockets and TV coaxial cable sockets.

At the time, I'd just put it away and hadn't thought any more about it. Now, having come across it again, I thought that I might as well test it to see if it was in working order, so that it could be put into service.

I plugged it in to the nearest power point, expecting that it probably wouldn't work. And I was right; with everything switched on, nothing happened. I checked the reset switch and it had been tripped, so I reset it. There was still no output from the unit, so that meant that I would need to pull it apart to find the problem.

The first challenge involved removing the screws at the back of the unit. They were Torx screws and while I had a Torx bit, the problem was that the screws were deeply recessed and my Torx bit was too wide to fit down the recesses. I then thought of a new screwdriver set I'd picked up a few days earlier. It had small straight screwdrivers in it and one of them fitted perfectly.

Once all the screws had been removed, I turned the unit over and lifted the top off, half-expecting to find the insides blown apart by a power surge. However, I could see no real damage at first. One thing that did become obvious though was a deposit of what looked like salt on the entire inside of the unit.

After removing the circuit board, this deposit was very evident over the track-work as well. I suspect that the unit may either have come from a coastal environment or someone had been using it near a salt-water pool or aquarium.

Surprisingly, this deposit was very easily removed using an old toothbrush and this resulted in a reasonably clean finish on both sides of the PCB (including the components). It was then that I saw what was obviously causing the fault. Both diode D1 (1N4007) and resistor R1 (270kΩ, 0.5W) were missing a lead at one end due to corrosion. In addition, the mini-neon "Protected" indicator was also missing one of its leads and the entire inside of its glass capsule appeared to have been taken over by a fungus.

I soon replaced both the diode and the resistor but the mini-neon was a problem because I didn't have an exact replacement. As a result, I looked through my various spares and eventually found a unit that I could cannibalise. This particular indicator had a slim case with a red lens and removing this lens revealed a neon which was the same size as the one I needed.

The only problem was that this neon had thick insulated leads crimped to the original thin bare leads coming from the glass capsule. In the end, I decided to cut the thick leads and the crimps off and replace them with some 0.4mm-diameter uninsulated hook-up wire, which matched the original wire thickness. The only problem with this was that the solder joint was then too thick to fit in the original grooves in the stand-off that held the neon at the correct height on the PCB. This was solved by using a half-round file to file small grooves in the stand-off.

Once all the new parts were in place,

The Things Some Customers Do

A little knowledge can be a dangerous thing, so the saying goes. That certainly applies to customers who fiddle with equipment and leave a booby-trap for an unsuspecting serviceman. L. G. of Cowes, Victoria, encountered one such case many years ago. Here's his story . . .

I was working in an electronics workshop in Canberra at the time. We serviced virtually anything electronic, including X-ray machines, robots, forensic equipment etc but our bread and butter was CRT computer monitor repairs.

In fact, we had a big monitor repair contract at the time with one government department which had some 4000 of the heavy beasts. And that was apart from the work we did for various schools, real-estate agents and over-the-counter customers

The most I ever managed to repair was 13 in one day. They came in with a myriad of faults, including switch-mode power supply problems, EHT faults and colour or other display problems.

We soon became experts in this field and zealously documented each fault and its repair. As a result, many repairs became quite routine, since there was no need to diagnose a fault that we'd seen many times before.

One particularly memorable day, I lifted a large monitor up onto my service bench and noted the customers fault description that it "won't fire up". After removing the back, the first step was to check for power and EHT. As a result, I connected an EHT probe to the tube and set up my VoltOhmyst meter to check for signs of life

Imagine my shock when, at switch-on, the needle immediately shot hard over past the 50kV mark, followed by an almighty crack and a spark that literally leapt across my 30cm-long EHT probe to my arm. I immediately fell to the floor with heart palpitations and the next thing I remember was my boss hovering over me saying "are you all right?" My answer was an emphatic NO!

Now the EHT probe had been connected to the VoltOhmyst via a screw-on type microphone connector and a hefty shielded cable. And somehow, no doubt due to the tremendous "belt" I had received, I had managed to rip this cable out of its socket without dislodging the meter off the shelf above!

So, why had the X-ray protection circuit not kicked in and shut the supply down after the EHT passed the 28kV mark? Well, it turned out that the customer knew about this circuitry and had worked out that if he disconnected it, the monitor would momentarily seem to "work".

Normally, such a high EHT would comfortably punch a tiny pin hole through the glass shell of the CRT and destroy the vacuum. In fact, no-one in our centre could ever fathom out why this hadn't occurred!

That incident was enough for me. I promptly black-banned this customer and never serviced any of his jobs ever again!

I very carefully set everything up with the top cover off and turned the power switch on. I then kept well clear of this potentially lethal arrangement while I plugged the power cable into an extension lead and turned on the power switch on at the wall socket. The "Protected" neon immediately lit up and there were no explosions, so I figured that the unit could now be reassembled.

As soon as it was back together again, I plugged it back into the wall socket, switched everything on and checked the six outlets with my power point tester. All tested correctly, so the unit can now be used again after its long rest on the scrapheap.

Of course, under normal circumstances, this unit would have been 'binned' because it's not considered to be a 'repairable' item – the cost of having it repaired at a service centre would well and truly exceed the cost of a new replacement.

From my perspective, it's handy to be able to do this sort of repair work and to be able to save an otherwise "dead" item from landfill. The parts cost would have been no more than a dollar or two at the most, whereas a new unit currently retails for $49.98. At that price, it was definitely worth spending some time to save it.

LED torch repair

Yet another job involved one of those small 9-LED torches. I use mine quite often but noticed recently that it wasn't working very well, a little "percussive maintenance" being required in order for it to give full brightness. The time had come for an overhaul.

My wife also has an identical torch and I had repaired it previously, so I was familiar with how these torches are dismantled. In the case of my wife's torch, half the LEDs had stopped working. When I dismantled it, I found that one of the surface-mount resistors had gone open-circuit.

The other resistor for the remaining LEDs was still OK, so I measured it and replaced the faulty one with a conventional resistor. Some time later, this torch suffered the same problem again, with the other surface-mount resistor going open-circuit and taking out its LEDs. It too was replaced with a conventional resistor.

So, back to my torch. I unscrewed the switch end, removed the battery pack and unscrewed the LED end from the main barrel. Looking at the rear of the LED assembly, there is a round retainer that has two holes in it. Needle-nosed pliers are used to unscrew this. Once removed, the LED assembly, reflector and lens can be removed.

When I removed the lens, I found that it was shattered around the outside edge, which explained why the torch had been behaving erratically. With everything at the front loose, the LED assembly could not make proper contact with the barrel.

So I needed a new lens but what to use? While I was contemplating what I could make a new lens from, I spotted a cracked CD case, with a clear polycarbonate lid. This would be ideal. I marked out a circle the correct size and cut it out roughly with a hacksaw blade, before finally filing it to size. The torch was then reassembled, after which it worked perfectly again. SC

UBCRIBING MAKE$ ENE...

because it saves you dollars!

If you regularly purchase SILICON CHIP over the counter from your newsagent, you can $ave more than 10% by having it delivered to your mailbox. Simply take out a subscription – and instead of paying $9.95 per issue, you'll pay just $8.75 per issue (12 month subscription) – and we pay the postage!

How can we do this?

It's all about economics. Printing enough copies to send out to newsagents, in the hope that they'll sell, is very wasteful (and costly!). When readers take out subscriptions, we know *exactly* how many copies we need to print to satisfy that demand. That saves us money – so we pass the savings onto our subscribers. It really is that simple!

You REAP THE BENEFIT!

But wait, there's more! Subscribers also automatically qualify for a 10% discount on any purchases made from the SILICON CHIP online shop: books, printed circuit boards, specialised components, binders – anything except subscriptions!

So why not take out a subscription?

You can choose from 6 months, 12 months or 24 months – and the longer you go, the bigger the savings.

You can choose the print edition, the online edition or both!

Most people still prefer a magazine they can hold in their hands. That's a fact. But in this digital age, many people like to be able to read SILICON CHIP online from wherever they are – anywhere in the world. That's also a fact. NOW YOU CAN – either or both. The on-line edition is exactly the same as the printed edition – even the adverts are included. So you don't miss out on anything with the on-line edition (flyers and catalogs excepted).

OK, so how do you go about it?

It's simple: you can order your subscription online, 24 hours a day (siliconchip.com.au/shop and follow the prompts); you can send us an email with your subscription request and credit card details (silicon@siliconchip.com.au), you can fax us the same information (02) 9939 2648 (international 612 9939 2648) or you can phone us, Monday-Friday, 9am-4.30pm, on (02) 9939 3295 (international 612 9939 3295).

Don't put it off any longer: $TART $AVING TODAY with a SILICON CHIP subscription!

PRODUCT SHOWCASE

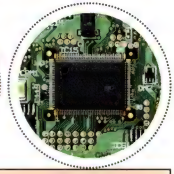
New express PCB services from QualiEco

The team at QualiEco Circuits Pty Ltd is well known for providing excellent quality electronic manufacturing services and solutions.

The company has recently launched express services in all product categories (refer to the advertisement on page 45 for more detail). Hundreds of customers in Australia and New Zealand have been enjoying excellent quality, low prices and on-time delivery for years. The company is now offering customised delivery solutions at affordable prices.

This vibrant, growing company offers outstanding technical support and attention to detail. Proud of providing reliable services for more than 11 years, QualiEco Circuits is currently a market leader in New Zealand. The company is now enjoying a successful third year of operation in Australia.

Contact the QualiEco Circuits Team today to get the best advice for your project, small or large.



Contact:
QualiEco
6/305 Grange Rd, Ormond Vic 3204
Tel: (1300) BUYPCB (1300 289 722)
Website: www.qualiecocircuits.com.au

Wiltronics' new RBX1 Desktop 3D Printer

3D printers have come a long way in recent times – no longer do they have to look like Heath-Robinson nightmares!

Typical of modern 3D printers is the Robox RBX1 Desktop 3D Printer which Wiltronics have introduced to their range.

It uses fused filament fabrication (FFF) which works in a similar way to a hot-melt glue gun, using plastic filament instead of glue sticks and a digitally controlled head to lay down material layer on layer to make three-dimensional parts.

With dual nozzles, it's up to 300% faster than others on the market. The dual nozzles mean the Robox can produce highly detailed exterior surfaces (the bits you can see) and quickly fill them using the larger nozzle.

The replaceable heated bed is easily removable and is made from PEI laminate which requires no tape, glues or special preparation.

Maximum build size is 210 x 150 x 100mm and layer resolution is as high as 20 microns,

You can download a product PDF from the Wiltronics website.

Contact:
Wiltronics
Unit 4 Cnr Ring Rd & Sturt St, Ballarat Vic 3350
Tel: (03) 5334 2513 **Fax:** (03) 5334 1845
Website: www.wiltronics.com.au

Colourful range of quality connectors from Germany

Enertel have been appointed the Australian distributors of the renowned German-made Schutzinger range of plugs, sockets, connectors, etc.

Apart from their outstanding quality, one of the features of the Schutzinger range is their range of colours. This means that equipment connections can be colour coded for instant recognition and fewer errors.

Enertel also supplies high voltage electrical components and specialised test equipment to the electrical supply industry, transformer manufacturers, motor rewind shops and large servicing organisations.

Contact:
Enertel
PO Box 784, Winston Hills NSW 2153
Tel: (02) 9674 4748
Website: www.enertel.com.au

ElectroneX returns to Sydney for 2014

electronics design & assembly expo

ElectroneX – The Electronics Design & Assembly Expo returns to Australian Technology Park, Sydney on 10-11 September.

Alternating annually between Melbourne and Sydney, this specialised event is the major focal point for the electronics industry in Australia, designed to help professionals across a vast array of industry sectors to stay in touch with the latest electronics technology developments for systems integration and production electronics.

Over 80 companies will showcase and demonstrate the latest new product releases for industry, scientific and commercial applications.

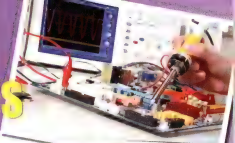
The SMCBA – Electronics Design & Manufacture Conference is being held in conjunction with the exhibition and attracted over 200 delegates at the last Sydney event.

Design, electronic & electrical engineers, OEM, scientific, IT and communications professionals and service technicians are invited to attend the event where they will find the latest technology driving future product & system developments.

Contact:
Australian Exhibitions & Events
Suite 11, 263 Lorimer St, Pt Melbourne, Vic 3207
Tel: (03) 9676 2133 **Fax:** (03) 9676 2533
Website: www.auexhibitions.com.au

ONLINE & IN STORE

WINTER DIY PROJECTS



Arduino Experimenters Kit

Servo motor, lights, buttons, switches, sound, sensors, breadboard, wires and more are included with a Freetronics Eleven Arduino compatible board in this extensive hobby experimenter and starter kit.

- Comprehensive instructions included
- No soldering required

XC-4262

$89.95

ELECTRICALS TOOL KIT

Great value for your money! This package includes a quality set of 7 screwdrivers that are GS and DVE tested and approved to 1000V. 5 stainless steel 115mm cutters/pliers with soft ergonomic grips. A "SMART" test screwdriver to check various electronic components and a 4 tray tool storage case.

$59.95

SAVE $23.85

Stainless Steel Cutter/Plier Set	TH-1812	$29.95
Screwdriver Set	TD-2022	$24.95
"Smart" Test Screwdriver	TD-2055	$11.95
4-Tray Tool / Storage Case	HB-6302	$16.95

Total package valued at $83.80

720 Lumen LED Driving Lights

Cost effective solution for the rough demands of 4WD or marine lighting applications. Equivalent to a 50W halogen. Spot or flood beam available. Waterproof. Alloy housing. Stainless steel mounting hardware. Sold in pairs.

- IP67 rated
- Voltage: 9-60V (10W)
- Size: 51(W) x 51(H) x 61(D)mm

Spot	SL-3939	$79.95
Flood	SL-3938	$79.95

NEW

$79.95 PAIR

DOUBLE POINTS!

HID Spot/Search Light

Produces 3200 lumens of white light reaching over 1000m, making it ideal for use in search and rescue missions, hunting or general spot lighting. Magnetic base with rubber pad, mount to your vehicle for use on the go.

- Wireless remote control (100m range)
- On/off, 360° pan & 120° tilt
- Power: HID-Xenon 35W
- Voltage: 12VDC

ST-3377

VIDEO ONLINE

NEW

$169

HD Car Event Recorder with GPS

Records 1080p footage to a microSD card (sold separately XC-4992 Class 10 32GB capacity $47.95) which can be viewed on the 2.7" LCD screen or by using the mini HDMI port (cable included) for easy playback on large screen TV. Charge from the supplied cigarette lighter charger.

- G-sensor for auto recording
- Displays GoogleMaps position, speed, date/time
- 5MP CMOS sensor
- IR LEDs for day/night use
- Size: 88(W) x 47(H) x 35(D)mm

QV-3842

1080p

NEW

$199

Jaycar Electronics

Better, More Technical

SIGN UP NOW & START EARNING POINTS

The Jaycar Rewards programme will entitle you to accumulate one point with every dollar spent* at any Jaycar Store* and be rewarded with a $25 Rewards Cash Card once you reach 500 points.

Register online today by visiting

www.jaycar.com.au/rewards

REWARDS SPECIAL!

Get DOUBLE POINTS on selected products in this promotion. Offer ends 23/07/14.

*Conditions apply, company stores only and only available for retail transactions in Australia and New Zealand. See website for full terms and conditions.

Pro Soldering Gas Kit

Excellent value and ideal starter kit.

- Kit contains pro gas soldering iron with tips, cutters, desolder braid, electrical shears, wire stripper/cutter/crimper with wire guide, soider splice heatshrinks and heatshrink pack

TS-1114 *$180 value on individual items*

$99

DOUBLE POINTS!

Four Zone Security Alarm with 2 Wire Technology

Simple and effective 4 zone DIY alarm system that enables you to set up multiple zones which can be monitored or enable independently (i.e. upstairs/downstairs or house & garage etc.) The system utilizes two-wire technology to ensure simple set-up.

- Kit includes main control unit, 2 x PIRs, 4 x reed switches, external siren, 50m two-core flat cable, 240V adaptor
- 3 modes of operation (Home, Out, Off)

LA-5475 **WAS $119**

$99

SAVE $20

Accessories to Suit:

2 Wire PIR LA-5476 $29.95

PIR Lens LA-5473 $6.95

SERIOUS SOUND

Rechargeable 8" PA Speaker

All-in-one compact mobile wireless sound system with built-in UHF wireless receivers. Includes one lapel mic and UHF belt pack transmitter.

- Bluetooth® wireless technology
- USB and SD card slots for MP3 playback
- Pole mount socket (no mounting hardware included)
- Max output power: 40WRMS
- Audio input: XLR for microphone, 1/4" for instrument, RCA for CD player, 3.5mm stereo input
- Audio output: 6.3mm (1/4") phone jack for recorder
- Size: 320(W) x 310(D) x 455(H)mm

CS-2510

NEW

$349.00

Threshold Voltage Switch Kit

Ref: Silicon Chip Magazine July 2014

Switches a relay when its input voltage crosses a threshold. Applications include activating a cooling fan or warning light when a particular temperature is reached or preventing a lead-acid battery from being over-charged. Suits 5V, 12V or 24V applications. PCB, onboard relay and components included. See website for more details.

- PCB size: 107 x 61mm

KC-5528

DUE MID JULY

NEW

$34.95

To order call 1800 022 888

www.jaycar.com.au

ARDUINO BOOKS

Getting Started with Arduino - 2nd Edition

This book is aimed for the first timer and explains what Arduino is, how it works, and what you can do with it.

- Soft cover, 128 pages
- Size: 216 x 140mm

BM-7131

$23.95 DOUBLE POINTS!

Programming Arduino: Getting Started with Sketches

An entry level book, introduces the Arduino programming language and then describes the basic configurations of Arduino modules.

- Soft cover, 162 pages
- Size: 138 x 215mm

BM-7133

$17.95 DOUBLE POINTS!

Arduino + Android the Evil Genius

A project oriented book written around Android-type mobile phones and the Arduino microcontroller.

- Soft cover, 197 pages
- 215 x 275mm

BM-7135

$34.95

ARDUINO COMPATIBLE BOARDS

LeoStick

A tiny Arduino-compatible board that's so small you can plug it straight into your USB port without requiring a cable!

- Analogue & digital I/O
- User-controllable RGB LED
- ATmega32u4 MCU with 2.5k RAM and 32k Flash

XC-4266

Also available: LeoStick Prototyping Shield XC-4268 $7.95

$29.95

Eleven

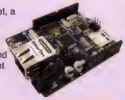
The "Eleven" is just like an Arduino Uno - but better! It's a microcontroller board based on the ATmega328 with 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

XC-4210

$39.95

EtherTen

Includes onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, and even Power-over-Ethernet support.



- ATmega328P MCU running at 16MHz
- 10/100base-T Ethernet built-in

XC-4216

$69.95

EtherMega

The ultimate network-connected Arduino-compatible board: combining an ATmega2560 MCU, onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, power-over Ethernet support, and even an onboard switchmode voltage regulator so it can run on up to 28VDC without overheating.

- 10/100base-T Ethernet built-in
- 54 digital I/O lines
- 16 analogue inputs

XC-4256

$119

Also available: Mega Prototyping Shield to suit XC-4257 $17.95

USBDroid with Onboard Android/USB Host

Specially designed to be compatible with the Android Open Accessory Development Kit. Connect your Android device like a mobile phone for all kinds of controller and networking features.

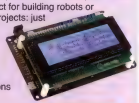
- Built-in charger

XC-4222

$69.95

StepDuino Arduino Compatible

A self-contained board with onboard stepper motor drivers, servo interface, microSD card slot, and 20x4 character LCD. Perfect for building robots or other mechatronics projects: just connect the stepper motors and go!



- 2 x 4-wire stepper motor controllers
- 1 x servo interface
- Serial communications header
- Compatible with the Arduino IDE

XC-4249

$149

ARDUINO SHIELDS

ProtoShield Short

A dedicated short version prototyping shield for EtherTen (XC-4216) and EtherMega (XC-4256) designed to fit neatly behind the RJ45 Ethernet jack, allowing you to stack your Ethernet-based projects right on top with standard headers.

- Pads available to fit a reset button
- Gold-plated surface

XC-4248

$4.95

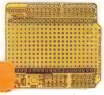
Limited stock. Hurry!

ProtoShield Basic

Low-cost Arduino prototyping shield that enables you to make more durable projects.

- Gold plated PCB surface
- Top and bottom overlay
- Yellow solder mask
- Clearly marked GND and 5V rails beside prototyping area

XC-4214



$4.45

433MHz Receiver Shield

Add a receiver module to your Arduino project to receive signals from 433MHz wireless devices including weather stations, home automation remote controls, power consumption meters, car alarms, etc. Supplied with 433MHz receiver module.

- Fully pre-assembled except for headers
- Includes stackable headers that you can solder in place
- Gold plated surface

XC-4220

$29.95

Terminal Shield

Breaks out all the Arduino headers to handy screw terminals, making it easy to connect external wires without using a soldering iron. Ideal for quick experiments or for robust connections!

- Gold-plated surface
- Large prototyping area

XC-4224

$16.95

H-Bridge Motor Driver Shield

Directly drive DC motors using your Arduino compatible board and this shield, which provides PWM (Pulse-Width Modulation) motor output on 2 H-bridge channels to let your board control the speed, direction and power of two motors independently. Perfect for robotics and motor control projects.

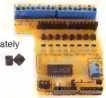
- Drives up to 2A per motor channel

XC-4264

$29.95

8 Channel Relay Driver Shield

Drive up to 8 relays from an Arduino using just 2 I/O pins. Perfect for home automation projects when combined with relay SY-4052 (available separately $8.95) and DIN-rail relay mounting base SY-4063 (available separately $4.95).



- LED status displays

XC-4276

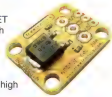
Also available: 4 Channel Relay Driver Module for Arduino XC-4278 $13.95

$34.95

ARDUINO MODULES

N-MOSFET Driver & Output Module

This high-power N-MOSFET module lets you switch high current loads using a tiny microcontroller. Works brilliantly for automotive projects such as switching high-power 12V lights and high wattage LEDs.



- Maximum 60V / 20A switched load

XC-4244

$6.95

Hall Effect Magnetic & Proximity Sensor Module

Sense magnetic presence, rotating wheels and magnets, door and arm sensors, and anything else magnetic nearby this sensor.

- Green "triggered" LED for easy setup and use
- 2.5 to 5.5V operation

XC-4242

$9.95

Real-Time Clock Module

Perfect for clock projects, dataloggers or anything that needs to know the date and time. Keeps accurate time for years using a tiny coin-cell, and is very simple to connect to your Arduino project.

- Battery included

XC-4272

$29.95

ICSP Programmer for Arduino

Program new applications into a wide range of microcontrollers using this ICSP programmer with a USB interface. Compatible with a wide range of microcontrollers, including all Arduino boards.

- Supplied with a USB cable and ISP programming cable

XC-4237

$24.95

DOUBLE POINTS!

ATmega328P MCU with Arduino Uno Bootloader

An Atmel AVR ATmega328P microcontroller to build customised Arduino compatible projects. Includes 16MHz crystal oscillator.

- Pre-installed Arduino Uno bootloader

ZZ-8726

$9.95

Standard DC Motors

Quality product with hardened drive shaft, sintered bearings and quality commutator brushes etc. Ideal for any application where a compact high torque and reliable motor is required.

- 2.3mm driveshaft
- M2.6 threaded mounting
- Solder tag terminals
- RPM shown at max power

6V	9,000RPM	YM-2712	$6.95
12V	8,100RPM	YM-2716	$8.95
12V	6,500RPM	YM-2718	$12.95

FROM **$6.95**

Limited stock

3-Axis Accelerometer Module

This module can operate in either +/-1.5g or +/-6g ranges, giving your project the ability to tell which way is up. Ideal for robotics projects, tilt sensors, vehicle dataloggers etc.

- Independent X, Y, and Z axis outputs
- Can run from either 5V or 3.3V

XC-4226

$19.95

Temperature Sensor Module

Collect temperature data using your Arduino! This 1-wire bus temperature sensor module is easy to connect and use. You can even daisy-chain several together on the same wire.

- -55 to +125˚C temperature range
- +/-0.5˚C accuracy
- Selectable 9 or 12 bit precision
- Unique device ID coded into every sensor

XC-4230

$16.95

USB-Serial Adaptor Module

Connects to the USB port on your computer and acts as a virtual serial port, converting the USB signals to either 5V or 3.3V logic level serial data.

- Size: 46(W) x 26(D) x 10(H)mm

XC-4241

$22.95

Breadboard

Mounted on a metal plate with 1680 tie points, 400 distribution holes and 1280 terminal holes.

- 3 banana terminals
- Size: 130(W) x 178(H)mm

PB-8816

$39.95

Standard 6V Servos with Metal Gear

Tough, metal geared servos for 1/10th and many 1/8th scale remote control cars, or robotic applications. Digital control, high torque and fast rotational speeds. Perfect where precise control and strength are needed.

- Operating voltage: 4.8 - 7.2V

Torque 4.8V: 13kg.cm
YM-2763 $29.95

Torque 4.8V: 11kg.cm
YM-2765 $29.95

$29.95 each

Humidity & Temperature Sensor Module

Measure temperature and relative humidity using a simple interface that requires just three wires to the sensor: GND, power, and data.

- -4˚C to +125˚C temperature range with +/-0.5˚C accuracy
- 0-100% relative humidity with 2-5% accuracy
- 3 to 5V operation

XC-4246

$19.95

IR Temperature Sensor Module

Connect this to your board and point it at a surface or heat source to remotely measure its temperature. This is our special version of the industrial infrared remote thermometer units with an onboard power supply, communication support and a software library with examples supplied.

- 3.3 to 5V operation
- -33 to +220˚C measurement range, 1 second response time

XC-4260

$34.95

ARDUINO DISPLAYS

128 x 128 Pixel OLED Display Module

High resolution, full colour OLED display module! Perfect for graphics, gauges, graphs, even make your own video game or interactive display.

- 16,384 full colour RGB pixels in a 128 x 128 format
- Active display area 28.8 x 26.8mm, (1.5" diagonal)

XC-4270

$49.95

RGB LED Cube Kit

This stunning 3D-matrix of 64 RGB LEDs incorporates an onboard Arduino-compatible controller so you can produce mesmerising light shows controlled by software. Use it as a mood light or create your own "ambient device" that gently notifies you of new email or instant messages. Some assembly required.

- 4 x 4 x 4 matrix of individually addressable 8mm RGB LEDs
- Size: 106(W) x 130(H) x 106(D)mm (assembled)

XC-4274

$89.95

4D Systems Intelligent Module with Touch

This pack allows for quick connection to existing Arduino projects to design and build. Includes a 3.2" LCD colour display with resistive touch and multiple input/outputs, a 4D Arduino shield and 5 way interface cable.

XC-4280

$119

SOLDERING KITS

Excellent value for money that includes all the soldering essentials for various projects.

TS-1652

Starter Kit

Pack includes 240V 20/130W turbo soldering iron, spare tip, stand, solder, metal solder sucker with spare tip and O-ring.
TS-1651

$24.95

DOUBLE POINTS!

Starter Kit with DMM

A complete set including multimeter, 25W soldering iron, de-soldering tool, screwdrivers, pliers and side cutters.
TS-1652

$34.95

DOUBLE POINTS!

500W Electric Drill

Powerful 240V electric drill suitable for a variety of tasks around the house or on the job.

- Forward/reverse switch
- Lock setting
- 10mm keyless chuck
- 1.8m cable

TD-2493

$19.95

DEAL!
Buy TD-2493 & TD-2151 for $29.90 save $10

Drill Assistant

Drill holes in walls easily, on the level and with no mess! Combination of laser leveler and drill dust collector lets you finish jobs in minutes.

- Requires 2 x AA batteries

TD-2151

$19.95

30 Piece Tool Kit with Case

Minor DIY repairs are a breeze with this 30 piece tool kit. The tools are held securely in a zip-up case. See website for contents.

- Case size: 210(L) x 160(W) x 48(H)mm

TD-2166

$24.95

Repair Kit For iPhone®

All the tools you need to take apart your iPhone® for DIY repairs. See website for contents.

- 19 pieces

TD-2113

$29.95

Gaming Console Tool Kit

Includes the tools required to open modern games consoles or handhelds to clean or repair them. See website for full listing.
TD-2109

$29.95

Electronic Tool Kit

Excellent tool kit for electronic or computer repairs with all the essentials - cutters, pliers, screwdrivers (Phillips head, slotted, Posidrive), nut drivers etc. See website for full contents.

- 30 pieces

TD-2107

$29.95

ELECTRONICS STARTER KIT

Working on electronic gear? This tool package includes screwdrivers that have ergonomic handles with fully insulated shafts rated for 1000V, a high quality small side cutter that has thick (2mm) blades, a low voltage circuit tester (6, 12 & 24V) and a storage box to keep your small electronic components together.

$29.95 SAVE $15.85

6-pce Electronic Screwdriver Set	TD-2026	$19.95
Stainless Steel Side Cutter	TH-1890	$13.95
Low Voltage Circuit Tester	TD-2049	$3.95
18 Compartment Storage Case	HB-6312	$7.95

Total package valued at $45.80

Rotary Tool Kit with Flexible Shaft

Powerful 32,000 RPM rotary tool with numerous attachments. 1m long flexible shaft. Suitable for model making, automotive, workshop, art, jewellery or sculpture. See website for full contents.

- 135W

TD-2459

$39.95

DOUBLE POINTS!

Automotive Crimp Tool with Connectors

The tool will cut & strip wire, crimp connectors and also cut a range of metric bolts. Every car enthusiast should have one of these.

- Includes male & female bullet & spade connectors + eyes and butt joiners

TH-1848

$13.95

PCB Etching Kit

An ideal kit for anyone needing to etch a circuit board - complete with an assortment of double-sided copper boards, etchant, working bath and tweezers. See website for full list of inclusions.
HG-9990

$27.95

Pre-cut Heatshrink Tubing - Trade Pack

Glue lined heatshrink in an array of sizes to suit all needs - 60 pieces in total. Supplied in see through nylon snap shut case.

- 95mm long heatshrink
- Case size: 205(W) x 108(D) x 35(H)mm

WH-5521

$29.95

WATCH REPAIR TOOLS

Jaycar has been fiddling with micro tools for years now, from tiny jewellers screwdrivers to small spanner sets to tiny table mounted vices etc.
We have discovered a source of reasonably priced watchmaker's tools. See our range below:

Watch Case Holder

Adjustable frame with 4 nylon retaining posts to enable a good safe grip on the watch case.
TH-1934

$8.95

Watch Case Opener

2-pce set. Can open cases 6-50mm in diameter.
TH-1929

$14.95

Watch Bracelet Link Removal Pliers

Remove and re-install little bracelet pins.
TH-1923

$29.95

Watchmakers Mallet

Features 6 interchangeable heads and weighs almost 90 grams.
TH-1927

$9.95

Watchmakers Kit

4 piece kit as shown.
TH-1932

$24.95

Limited stock on sale items

MP3 FM Modulator with Remote - 12/24V

Play music over an FM band on your car stereo. Backlit LCD. Fully adjustable arm for multi angle viewing.

- Accepts SD/MMC, USB or aux input
- 12/24VDC operation
- Includes infrared remote control

AR-3136

NEW

$14.95

HANDS-FREE MICROPHONES

Stereo Bluetooth® Hands-free Car Kit

Plugs into the car's MP3/AUX 3.5mm jack for hands-free functionality with any Bluetooth® enabled Smartphone.

- 12/24VDC
- Bluetooth® 4.0

AR-3130

NEW

$39.95

KEEP YOUR HANDS ON THE WHEEL

Bluetooth® hands-free connectivity for your Smartphone or Tablet.

Rechargeable Visor Mount

Safe, compact and lightweight unit for receiving phone calls whilst driving. Allows two phones to connect simultaneously.

- Built-in microphone and speaker
- 12VDC cable and charger included

AR-3134

NEW

$29.95

Plug & Pair

Plug into car's cigarette lighter for power and pair with your Bluetooth® enabled Smartphone for hands-free functionality.

- FM transmitter for audio through vehicle radio
- 12/24VDC
- USB charging port (1.0A)

AR-3132

NEW

$39.95

Panel Mount Bluetooth® Receiver with Microphone

Allows you to stream music from any Bluetooth® enabled device over your car/marine radio. Features a microphone for hands-free calling. One-knob volume and track control.

- 12VDC
- Bluetooth® 3.0

AR-3129

NEW

$49.95

Sticky Grip Phone Holders

Quick, easy and secure way to hold your phone as you drive. Just press your phone onto the sticky pad! No residue and can be easily cleaned. Two mounting options:

Dash/Vent Mount HS-9050 $17.95
Windscreen Mount HS-9052 $17.95

NEW

$17.95 ea

5 in 1 Easy Tester

Passive, quick and easy testing solution that performs five essential tests in the field: voltage, load, polarity, voltage drop and continuity.

- 12VDC

QP-2215

$9.95

Alternator and Battery Monitor

Simply plugs into your car's cigarette lighter socket to indicate alternator and battery status. Compatible with 12VDC systems.

PP-2142

$9.95

DOUBLE POINTS!

Battery, Charger and Alternator Tester

Quickly check the condition of your vehicles battery, charger or alternator. Uses three LEDs to indicate battery condition.

- Compact and lightweight

QP-2258

$12.95

Car Battery Monitor

Simply plug into the cigarette lighter socket and get an instant LED readout of the car's battery voltage.

- Operating voltage: 8 - 28VDC

QP-2220

$19.95

DOUBLE POINTS!

WORKBENCH EQUIPMENT

60W ESD Safe Solder/Desolder Rework Station

Complete solder/desolder station for production and service use.

- Microprocessor controlled
- Dual LCD displays
- Temperature range 160˚C to 480˚C
- Celsius and Fahrenheit display

TS-1574 **WAS $299.00**

$269

SAVE $30

0 to 32VDC Dual Output Laboratory Power Supply

Effective, dual 0 to 32VDC 3A power supplies in one case. The two outputs can be operated independently, connected in parallel, or series for multiple output currents and voltages. Backlit and easy to read display.

- Output voltage: 2 x 0 - 32VDC
- Output current: 0 - 3 Amps (x 2)
- Weight: 10kg approx.
- Size: 185(H) x 260(W) x 400(D)mm

MP-3087 **WAS $349.00**

$299

SAVE $50

25MHz Dual Channel Digital Storage Oscilloscope

Ideal for the advanced hobby user or technician and is particularly suited to audio work. See online for more details.

- 145mm colour TFT LCD
- Size: 310(W) x 150(H) x 130(D)mm

QC-1932 **WAS $499.00**

$469

SAVE $30

Dynamo-Powered DMM

Crank the handle for 10 seconds to provide power for approx. 10 minutes operation. No batteries required. Cat III, 600V. 10A current.

- Data hold
- Capacitance and frequency

QM-1547

$19.95

Limited stock.

Autoranging Pocket DMM

Handy pocket DMM packed with features.

- Large LCD display
- 4000 count
- Cat III, 600V
- Autoranging
- Capacitance
- Frequency
- Data hold and relative functions

QM-1328

$29.95

DOUBLE POINTS!

Pro High Temperature Non-Contact Thermometer

Professional grade infrared thermometer allows you to measure high temperatures safely.

- Temperature range: -50 to +1000˚C (-58 to +1832˚F)
- 30:1 distance to spot ratio
- Built-in laser pointer
- Automatic data hold
- Backlit LCD
- Moulded carry case

QM-7226 **WAS $189.00**

$169

SAVE $20

Wireless ADSL2+ Modem Routers

High performance routers that provide full ADSL2+ capability and superb reliability as a cost-effective networking solution for the home. They allow up to 4 wireless SSIDs which would let you create wireless nodes with varying permission levels.

- Complies with ADSL2/2+ standards with downstream and upstream data rates up to 24Mbps and 1Mbps
- Wi-Fi 802.11b/g/n compatible
- 4 x 10/100Mbps RJ-45 Ethernet ports

N150* **YN-8340 $59.95**
N300 with USB Sharing** **YN-8342 $84.95**

* Not available in NZ
** Due end July

NEW
FROM $59.95

3D PRINTER KIT - BRING YOUR 3D CREATIONS TO LIFE!

Supplied as a DIY kit, once assembled you can turn 3D digital images into real life plastic objects. A very fast, reliable and precise 3D printer that won't break the bank.

Can print objects with maximum dimensions of 200 x 200 x 200mm, in either ABS or PLA plastics (available separately).

This is an advanced level constructional kit, average build time is 3 - 4 days. For more information on assembly and the tools required please visit our website. Extensive online community support is also available at: www.k8200.eu

TL-4020

Filament not included

NEW
$1299

http://bit.ly/TL-4020

ACCESSORIES TO SUIT:

3D Printer Controller Module	TL-4022	$149.00
3D Printer LED Light	TL-4024	$34.95
1.75mm PLA 3D Printer Filament	TL-4060	$44.95
3.00mm PLA 3D Printer Filament	TL-4062	$44.95
1.75mm ABS 3D Printer Filament	TL-4070	$42.95
3.00mm ABS 3D Printer Filament	TL-4072	$42.95

NETWORKING

1Gbps PCI-E Network Card

Upgrade your PC with this 1Gbps PCI-Express Network card. Comes with a standard and mini-ATX brackets for home theatre PCs or small servers.

- Compatible with 10/100/1000Mbps speed networks
- Windows compatible
- Size: 65(L) x 66(W)mm

YN-8073

NEW
$19.95

USB 3.0 Gigabit Ethernet Adaptor

Provides a high performance 10/100/1000Mbps Ethernet connection for your laptop, desktop, MacBook®, or tablet.

- Size: 45(L) x 25(W) x 15(H)mm

YN-8408

$49.95

3 Port Ethernet Adaptor

Extend your home/office network over your mains power line. Simply plug the adaptor into a mains outlet then connect to your router. Features 3 x 10/100Mbps RJ-45 ports.

- Energy saving mode if no data is transmitted
- Operating range: Up to 300m

YN-8354

NOTE: Mains wiring must be on the same circuit phase

NEW
$129

HIGH SPEED DUAL BAND

Universal Wi-Fi Extender

Eliminate Wi-Fi dead zones and extend the range of existing networks. Dual band. Increased speed up to 300Mbps. Works with both 2.4GHz and 5.0GHz routers.

- Wi-Fi protected setup (WPS)
- 802.11N

YN-8364

$89.95
DOUBLE POINTS!

Wireless Network Adaptor

Micro sized, 802.11ac 600 dual band connectivity for maximum speed and performance.

- Wi-Fi protected set-up (WPS)
- USB2.0
- 5GHz max speed: 433Mbps
- 2.4GHz max speed: 150Mbps

YN-8328

NEW
$39.95

USB 3.0 Male A to Micro B Lead

Connects your computer to the latest micro-USB 3.0 peripherals, such as external HDD's, printers and scanners.

- 1.8m

WC-7774

$14.95

8 Port Ethernet Switches

Enhance network performance and efficiency. Mains powered or via USB port. Supports auto-negotiation and cable length detection. Includes power supply and USB power adaptor.

- 5VDC
- 8 x RJ-45 ports
- Compact size 137(L) x 76(W) x 25(H)mm

10/100Mbps N-Way Switch
YN-8077 $24.95

10/100/1000Mbps N-Way Gigabit Switch
YN-8078 $59.95

NEW
FROM $24.95

Wireless 802.11n Intelligent Routers

Combines three networking tools into one: Wi-Fi range extender, Wi-Fi access point or a wired/wireless router. Fully supports 802.11b/g/n standards and provides excellent wireless coverage.

- 1 x RJ-45 Fast Ethernet WAN port
- 4 x RJ-45 Fast Ethernet LAN ports
- WPS (Wi-Fi Protected Setup)
- WEP, WPA & WPA2 encryption

150Mbps
YN-8325 $39.95

300Mbps
YN-8327 $59.95

FROM $39.95
DOUBLE POINTS!

Range of original RRP. Limited stock on sale items.

IMPROVE YOUR TV RECEPTION

4G/LTE Filter for Digital TV Reception

Blocks unwanted signals from 4G/LTE mobile transmitters giving you clear uninterrupted reception.

- In-line coax connection
- Waterproof design
- Frequency range: 5-790MHz
- No power supply required

LT-3062

NEW

$14.95

Single Output Plug-in Indoor TV Booster

Simple and neat solution to boosting your TV antenna signals. Plug into a mains outlet for up to 20dB of signal amplification.

- F connector in, F connector out
- Frequency range: 46-860MHz
- Gain control: 15dB VHF, 10dB UHF

LT-3285

NEW

$39.95

MHL to HDMI Converter

Connect this MHL (Mobile High-Definition Link) to HDMI converter to your HDTV (HDMI cable not included) to view full 1080p video at 30/60Hz or mirror everything on your MHL equipped device. Supplied with an 11 pin micro-B adaptor for use on Samsung® S3/4 or Note 2.

- Supports most Android Smartphones & Tablets
- Requires USB power
- Lead Length: 90(L)mm

WQ-7424

NEW

$23.95

HDMI Over Cat 5/6 Extender

Extend your HDMI signal up to 60m* using a single CAT 5/6 cable. Both unshielded twisted pair (UTP) and shielded twisted pair (STP) cables may be used, however shielded is recommended.

- Supported resolution: 480p, 720p, 1080i, 1080p
- Mains adaptor included

AC-1681

Limited stock.

$129

NOTE: *Distance will vary depending on the resolution and cable specifications used. See website for full specifications.

4 Port HDMI Splitter

Share the latest HD movies, TV shows, music videos, corporate videos from a Blu-Ray player, HD media player or digital set top box across multiple displays. Supports stunning 3D content and 4Kx2K resolution.

- 1 x HDMI input; 4 x HDMI outputs

AC-1702

Limited stock
Not available online

$99

DOUBLE POINTS!

5 Input HDMI Switcher

Switch your TV display between a Blu-ray player, Playstation or other HDMI source with ease. One-touch button. Supplied with remote control.

- Support HDMI 1.4
- 5 x HDMI inputs; 1 x HDMI output

AC-1706

NEW

$59.95

DOUBLE POINTS!

5.8GHz Wireless AV Sender with IR Extender

Transmit quality audio and video around the home or office without running cables. Works with a range of remotes including Pay TV remotes. Includes power supply and RCA cables.

- 50m range
- Interference free

AR-1910

$89.95

WATCH TV ALL OVER THE HOUSE!

Spare receiver available separately: AR-1911 $49.95

2.1 Speaker Subwoofer Package

Combines our 8" subwoofer (CS-2433) and a pair of 2.5" cube speakers (CS-2431), great for a home theatre or gaming console. Just add a speaker cable.

- 120WRMS
- Subwoofer size: 350(L) x 260(W) x 315(H)mm
- Cube speaker size: 90(H) x 88(W) x 100(D)mm

CS-2434

$169

In-Wall 6.5" 2 Way Speaker with Swivel Tweeter

Designed for use when space is limited. Features fold out mounting clamps for easy installation and a flush mount cover to conceal the speaker.

- 25mm silk dome tweeter
- Swivel tweeter mount
- Power: 30WRMS
- Sold individually

CS-2464 **WAS $59.95**

$49.95 SAVE $10

Limited stock. Hurry!

8" Indoor/Outdoor Speakers

Versatile speakers that can be mounted to a wall or ceiling and can be rotated 180˚ for perfect sound projection.

- Power: 50WRMS
- Sold as a pair

CS-2478

WAS $149

$129 SAVE $20

Stereo Amplifier with Remote Control

Higher power with a USB MP3 player function in a standard Hi-Fi component size.

- 2 x 200WRMS channel
- Inputs: DVD/CD, aux 1&2, phono, tape, USB, tuner
- 20Hz - 20kHz frequency
- Size: 430(W) x 241(D) x 114(H)mm

AA-0484 **WAS $329**

$299 SAVE $30

2.4GHz DIGITAL Wireless Audio Amplifier

Send crystal clear 2.4GHz audio from your Hi-Fi or portable music device to speakers up to 20m away without messy wiring. Power supplies included.

- Power: 2 x 15WRMS (4 ohms)
- 3.5mm local input for Smartphone or MP3 player connectivity
- Mains or battery operated

AR-1895

$99

Ultra-thin 5" 2 Way Speakers

Consist of 5" woofer/mid and a 30mm mylar dome yet they are less than 45mm in depth each.

- Power: 30WRMS
- Wall mount
- Sold as a pair

CS-2461

$79.95

DEAL!
Buy AR-1895 & CS-2461 for $149 save $29.95

Dual Channel / Bridged Rack Mount Amplifiers

Versatile rack mount amplifiers that suit a variety of applications. Solid aluminium chassis and front panels.

- Dual channel / bridged
- Fan cooled
- Separate level controls for each channel
- Clipping and overload protection indicator LEDs
- 2U rack mount / 3U subwoofer amplifier

FROM $179

SAVE $20

200W AA-0477 WAS $199 NOW $179 SAVE $20
400W AA-0479 WAS $299 NOW $249 SAVE $50

DIY SECURITY & LIGHTING PROJECTS

DIY WI-FI IP CAMERAS WITH IR

DIY surveillance cameras that you can view with your web browser or Smartphone app when you're away from home. Designed to work with any common household Wi-Fi router to enable quick and easy set-up with broad device compatibility. Motion alarm detection. MJPEG video. 1/5" colour CMOS sensor. IR LEDs for day/night use.

Wi-Fi IP Camera

Our entry level DIY IP camera. Great for checking up on the house while you're out and about

QC-3832 **WAS $89**

$79 SAVE $10

Pan/Tilt Wi-Fi IP Camera

Pan/tilt functionality so you can change the view angle as you please.

QC-3834 **WAS $119**

$99 SAVE $20

Dome Wi-Fi IP Camera

For areas needing to convey a sense of professional monitoring such as retail stores, workshops etc.

- 60° angle

QC-3831 **WAS $89**

$79 SAVE $10

Outdoor Wi-Fi IP Camera

Designed for external use with its tough aluminium housing.

QC-3836 **WAS $149**

$119 SAVE $30

REWARDS SPECIAL!

Sign-up now and get DOUBLE points on selected products in this promotion. See page 1 for more details.

Jaycar REWARDS

LED Daytime Running Lights Kit

Attractive and subtle lights for your car or truck that increase vehicle visibility and enhance safety when driving during the day. Kit includes 10 lights.

- 70 lumens
- 12/24VDC
- Dustproof and waterproof
- Supplied with appropriate size hole saw for installation
- Size: 23(Dia) x 24(L)mm

SL-3457

NEW

$99

NOTE: Check your local State laws when using and installing these lights.

SUPERBRIGHT LED WORKLIGHTS

High brightness, long life LED worklights suitable for illuminating a warehouse, automotive workshop etc. Features a high-strength tempered glass cover with a high-pressure die cast aluminium shell. Extremely low wattage keeps running costs down with an energy efficiency greater than 90%. Environmentally friendly. IP65 rated.

500 Lumen 10W

- Rechargeable

SL-2809

$74.95 DOUBLE POINTS!

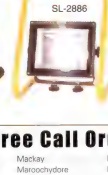
1500 Lumen 30W

- Rechargeable

SL-2886

$119 DOUBLE POINTS!

SL-2809



SL-2886

NEW STORE - FAIRY MEADOW

Visit us at

99 Princes Highway NSW 2519

ph: (02) 4225 0969

Parking available!

12VDC LED Brake Light Strips

Compared to normal incandescent bulbs LEDs are brighter, which makes them easier to see from a distance and light up quicker. 3 piece design, durable construction and waterproof for exterior mounting. Install in minutes using 4 pin SAE plug.

- 1.5m
- 90 x red LEDs
- Size: 1524(L) x 22(W) x 5(H)mm

SL-3962

NEW

$49.95

YOUR LOCAL JAYCAR STORE - Free Call Orders: 1800 022 888

• AUSTRALIAN CAPITAL TERRITORY

Belconnen Ph (02) 6253 5700
Fyshwick Ph (02) 6239 1801

• NEW SOUTH WALES

Albury Ph (02) 6021 6788
Alexandria Ph (02) 9699 4699
Bankstown Ph (02) 9709 2822
Blacktown Ph (02) 9678 9669
Bondi Junction Ph (02) 9369 3899
Brookvale Ph (02) 9905 4130
Campbelltown Ph (02) 4625 0775
Castle Hill Ph (02) 9634 4470
Coffs Harbour Ph (02) 6651 5238
Croydon Ph (02) 9799 0402
Erina Ph (02) 4365 3433
Fairy Meadow NEW Ph (02) 4225 0969
Gore Hill Ph (02) 9439 4799
Hornsby Ph (02) 9476 6221
Liverpool Ph (02) 9821 3100
Maitland Ph (02) 4934 4911
Newcastle WE NOW MOVED Ph (02) 4968 4722
Penrith Ph (02) 4721 8337
Port Macquarie Ph (02) 6581 4476
Rydalmere Ph (02) 8832 3120
Sydney City Ph (02) 9267 1614
Taren Point Ph (02) 9531 7033
Tuggerah Ph (02) 4353 5016
Tweed Heads Ph (07) 5524 8566
Wagga Wagga Ph (02) 6931 9333
Warners Bay Ph (02) 4954 9100
Wollongong Ph (02) 4226 7089

• NORTHERN TERRITORY

Darwin Ph (08) 8948 4043

• QUEENSLAND

Aspley Ph (07) 3863 0099
Browns Plains Ph (07) 3800 0877
Caboolture Ph (07) 5432 3100
Cairns Ph (07) 4041 6747
Caloundra Ph (07) 5491 1000
Capalaba Ph (07) 3245 2014
Ipswich Ph (07) 3282 5800
Labrador Ph (07) 5537 4295
Mackay Ph (07) 4963 0611
Maroochydore Ph (07) 5479 3511
Mermaid Beach Ph (07) 5526 6722
Nth Rockhampton Ph (07) 4926 4166
Townsville Ph (07) 4772 5022
Strathpine Ph (07) 3889 6910
Underwood Ph (07) 3841 4888
Woolloongabba Ph (07) 3393 0777

• SOUTH AUSTRALIA

Adelaide Ph (08) 8231 7355
Clovelly Park Ph (08) 8276 6901
Elizabeth Ph (08) 8255 6999
Gepps Cross Ph (08) 8262 3200
Modbury Ph (08) 8265 7611
Reynella Ph (08) 8387 3847

• TASMANIA

Hobart Ph (03) 6272 9955
Launceston Ph (03) 6334 2777

• VICTORIA

Cheltenham Ph (03) 9585 5011
Coburg Ph (03) 9384 1811
Ferntree Gully Ph (03) 9758 5500
Frankston Ph (03) 9781 4100
Geelong Ph (03) 5221 5800
Hallam Ph (03) 9796 4577
Kew East Ph (03) 9859 6188
Melbourne WE NOW MOVED Ph (03) 9663 2030
Mornington Ph (03) 5976 1311
Ringwood Ph (03) 9870 9053
Rosburgh Park Ph (03) 8339 2042
Shepparton Ph (03) 5822 4037
Springvale Ph (03) 9547 1022
Sunshine Ph (03) 9310 8066
Thomastown Ph (03) 9465 3333
Werribee Ph (03) 9741 8951

• WESTERN AUSTRALIA

Joondalup Ph (08) 9301 0916
Maddington Ph (08) 9493 4300
Mandurah Ph (08) 9586 3927
Midland Ph (08) 9250 8200
Northbridge Ph (08) 9328 8252
Rockingham Ph (08) 9592 8000

Arrival dates of new products in this flyer were confirmed at the time of print but delays sometimes occur. Please ring your local store to check stock details. Savings off Original RRP.
Prices valid from 24th June 2014 to 23rd July 2014.

HEAD OFFICE
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

ONLINE ORDERS
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

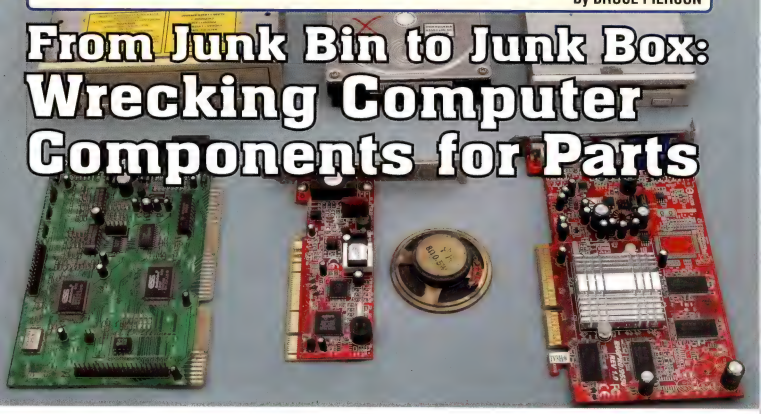
Occasionally there are discontinued items advertised on a special / lower price in this promotional flyer that has limited to nil stock in certain stores, including Jaycar Authorised Stockist. These stores may not have stock of these items and can not order or transfer stock.

Jaycar electronics Better, More Technical

Salvage It!

By BRUCE PIERSON

From Junk Bin to Junk Box: Wrecking Computer Components for Parts



That "latest and greatest" computer you proudly bought three or four years ago is today's door stop. Even *if* it still works, it's as slow as a wet week and probably doesn't even run today's software. In this final instalment in the "wrecking computers" series, we look at what you can do with it – or any other obsolete/dead components?

Well, you could wreck them for parts. A good idea is to have a "junk bin" and toss anything that's no longer needed into it. Junk Bin? What's the difference between that and the "junk box?"

Every hobbyist has a junk box: a place where you store an assortment of (usually) used or surplus parts that are too good to throw out and just might be useful . . . one day.

On the other hand, a junk bin is like a "half way house" where you toss old and dead stuff, ready for wrecking (one day!), to get the parts to feed your junk box.

So you have a look in your junk bin and you might find, just like those pictured above:

- an old CD-ROM drive (still works but far too slow to be of any use)
- a dead hard drive (well, your computer doesn't recognise it so you think it's dead)
- a definitely dead floppy drive (umm, what's a floppy disk!!)
- a dead sound card
- a dial-up modem (wow!)
- a ratty old speaker
- and a dead graphics card

You have some spare time, so you decide to reduce the amount of stuff in your junk bin, so that you can increase the amount of stuff in your junk box.

So where do we start?

The CD-ROM drive will be a good starting point. Usually, you can find four screws on the bottom. Once these are undone, the unit can usually be taken apart, sometimes requiring undoing some clips in the process.

Then the front panel can be unclipped and the inside parts removed from the case. Then it's just a matter of undoing screws and clips until you have everything removed.

The PCB can then be processed for useful components using a soldering iron for the delicate components and then the blowtorch method for the rest of the components (see

The remainder of the hardware really is junk to be binned.

So let's move on to the hard drive. Start by undoing any screws on the top cover. Then remove all the stickers, because the stickers may well be hiding two or three more screws, which must be removed before the top cover can be lifted off.

Then it's just a matter of undoing screws until everything is in pieces and you can see what you have from the exercise.

You will need a small Torx bit for most hard drives, to remove the drive platter(s). The PCB on the bottom may be held on by Philips screws or Torx screws and in a few cases, Torx screws may be used on the case. It varies depending on the manufacturer and the size of the hard drive.

Now for the floppy drive: there could be some screws holding the top on, or it could be just clipped on. There's a wide variety of floppy drives and they vary as to how they are held together.

Just undo any screws you find and un-clip any clips you find until the unit is completely dismantled. There's usually a few components on the PCB that can also be salvaged in the process.

Some of the more delicate items will need to be removed with a soldering iron before the rest can be blow-torched off.

The sound card, dial-up modem and graphics card can be processed using the same approach. First, unscrew any screws, remove any jumpers and take off any heatsinks or other attachments.

Arguably the jumpers and the heatsinks will be the most useful bits for your junk box! But the components can be removed with a soldering iron or blowtorch and the remaining junk binned.

The speaker? What is there in a speaker, you ask? A nice, powerful little magnet that will make a quite good fridge magnet, if nothing more. To remove it, just grab some pliers and bend the front frame up until it comes off the magnet and there you have it.

So, what did we get from these dead and obsolete components?

The picture below shows the range of parts that was salvaged from each of the obsolete and dead items.

Newer or older types of similar items will have a slightly different selection of parts, compared to these particular items.

Here are the parts we salvaged for our junk box, as photographed below:

From the CD-ROM drive:
Two motors, one a stepper type (with a gear) and one a DC type, to load and eject the disc (with a pulley). *(I once used a tray motor from a dead CD-ROM drive to repair a DVD player with a faulty tray motor.)*
One drive belt to suit the tray motor
Two rods
One small magnet
26 assorted screws,
Two tactile switches
18 electrolytic capacitors
Six rubber mounts
One jumper
One LED
One 3.5mm stereo socket
One 3-position, centre-off momentary switch
One PCB-mount dual potentiometer
A few gears
A selection of SMD components.

From the hard drive:
Two very powerful magnets. *(Be careful with these as they can be quite savage. I suffered a crushed thumb when holding one of these magnets and getting too close to the other one, which jumped up to meet the first one, crushing anything in its path, which happened to be my thumb!*
One platter (unknown use)
Two bearings,
One shaft
One magnetic washer
One washer
Four aluminium brackets
One jumper
25 assorted screws
Several SMD components.

From the floppy disk drive:
One 33-pin connector
One power connector
Five springs
19 assorted screws
One shaft
One bush
One LED
One electrolytic capacitor
One resistor
Three micro-switches

They won't take up much storage space . . . so why not store 'em! You never know when you'll need a couple of 'XYZ' widgets and you just happen to have a couple, removed from that old computer!

Four short lengths of hookup wire
Some SMD components.

From the sound card:
Six headers
Four 3.5mm stereo sockets
One small transistor
Eight wire inductors,
One crystal
Four ICs
14 electrolytic capacitors
Some SMD components.

From the dial-up modem:
One isolation transformer
One small PCB speaker
Two small transistors
One crystal
Two greencap capacitors
One ceramic capacitor
One small round bridge rectifier
Two screws
Six electrolytic capacitors
Two opto-couplers
A few SMD components.

From the speaker,
A useful small magnet, which is quite strong for its size.

There are usually two different types of 57mm speakers in computers. The other type has a smaller magnet, which can also be salvaged using the same method.

From the video card:
One heatsink
Four screws/nuts from the video connectors
18 electrolytic capacitors
Three video connectors
Two 3A diodes
One inductor
One crystal
Some SMDs components.

So, that was quite a surprise as to just what was salvaged from those dead and useless items. At first glance, it may have seemed that some of the items would not have anything much in them worth salvaging but a closer look revealed quite a lot of goodies.

It was worthwhile to salvage these parts before binning the leftover junk.

Some of the items had some SMD components in/on them. These were salvaged by heating the back of the PCB until the solder holding the SMDs on melted and then the PCB was knocked on a hard surface to dislodge the SMDs. It's really not much use saving any SMD that is tiny with multiple leads, but small capacitors and resistors may be useful for a project or repair in the future.

You may have noticed that I haven't yet tried to identify the small components above. That's a job for another day, as at the same time I always test any component before using it, otherwise I may be introducing a fault that wasn't there to start with! SC

ICOM

A touch of class

IC-7100

Introducing the new IC-7100 multi-mode amateur transceiver.

Featuring an intuitive remote head touch screen display, D-STAR DV mode communication and intelligent auto-tuning operation with the optional AH-740 antenna.

AH-740
HF Antenna

D-STAR

To find out more about our latest products,
call Icom on 03 9549 7500
or visit www.icom.net.au

ICOM 7100

By GEOFF GRAHAM

Micromite, Pt3: Build An ASCII Video Terminal

Now you can build your own VT100-compatible ASCII Video Display Terminal. It uses just one chip and lets you add a video display, keyboard and USB to your next microcontroller project. It's the perfect companion for microcontrollers with serial input/output such as the Micromite and the PICAXE.

MANY OLDER readers will remember the days when an ASCII terminal was the standard method of interfacing to a computer. In those days, the DEC VT100 was the "gold standard" for such a terminal. It had a keyboard, a 24 x 80 character display and an RS232 interface to allow connection to a multi-user minicomputer.

That all changed with the introduction of the PC with its integrated display and networking over Ethernet. In recent years though, there has been a resurgence of serial communications. A serial interface is easy to implement on a microcontroller and devices such as the Micromite and PICAXE use serial as their basis for communications, as do many others.

You could use a PC or Mac to connect to these microcontrollers via a serial port but they are large and clumsy and not a long-term solution if your project needs a permanent display. That's where this ASCII Video Terminal comes in. It uses a single chip to add video, a keyboard and USB to an external microcontroller via a serial interface.

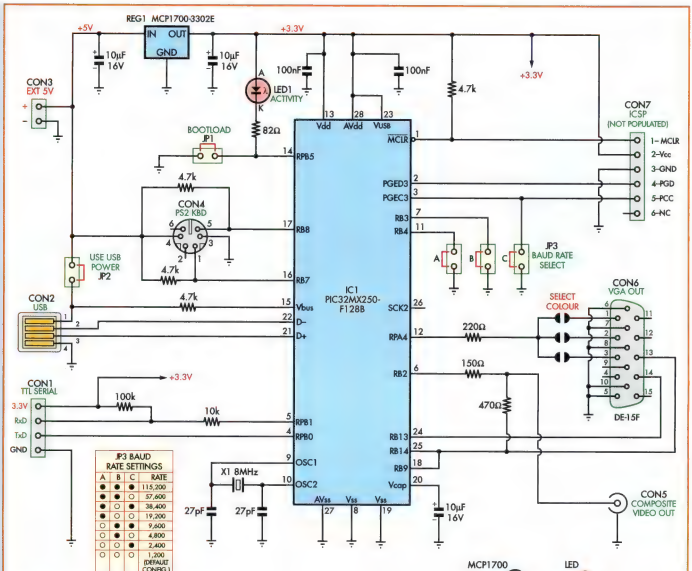
Other (more powerful) small computers also often rely on a serial interface. For example, the Raspberry Pi puts out a series of informative diagnostic messages on its serial interface as it boots up and this project will display them for you. Once the Raspberry Pi has booted, you can then log into it via this serial interface using the terminal's keyboard.

By the way, the term ASCII refers to the character encoding standard used by the VT100. Back in the days of the VT100, there were other competing standards such as EBCDIC (used by IBM) but these days all serial communications use ASCII.

Main features

An accompanying panel lists the main features of the ASCII Video Terminal but in summary you can use either a VGA monitor, a composite monitor or a TV (PAL or NTSC) to display the video output. As indicated, the input can either come from a standard PS/2 keyboard or from a PC via the USB interface.

Any of these I/O facilities can be left out if you don't need them. For example, if you simply wanted to add



SC 130114 ASCII VIDEO TERMINAL

Fig.1: the circuit is based on a PIC32MX250-F128B microcontroller (IC1). The table at bottom left shows the range of baud rates that can be selected using jumper block JP3. A black dot indicates that a jumper should be placed at that position. The default (no jumpers) can be set using the Set-up menu to any speed between 40 and 1,000,000 bps, the default being 1200bps.

a small video display to a PICAXE project, you could do this by using the terminal's microcontroller and seven other passive components to drive a low-cost reversing camera monitor. The USB and keyboard parts can be left out if not required, resulting in a simple, low-cost display.

You can use the same minimalist approach with the Silicon Chip Micromite (see May & June 2014 issues). However, the full ASCII Video Terminal with a keyboard and display works particularly well with this device. Together, the two provide almost the same functionality as our popular Maximite but in two low-cost 28-pin chips.

This is the key to this project. You can build the full ASCII Video Terminal on a PCB as described here or you can just pick the parts that you need and incorporate them into your own project. Because this project is based on a single low-cost and easy to solder microcontroller, this is easy to do.

Circuit details

Refer now to Fig.1 for the complete circuit details of the ASCII Video Terminal. This shows just how simple the project really is. It's based on a single, yet powerful, PIC32 microcontroller from Microchip. This 28-pin chip generates the video, handles the keyboard and also manages the serial and USB interfaces. The other components are mostly there to ensure correct signal levels.

The PIC32MX250F128B microcontroller (IC1) used here is a close cousin to the recommended chip for the Micromite, the only difference being that this one supports USB. So if you have the facilities to program the chip used in the Micromite, you can also program this device. If you don't want to do that, you can purchase a

The ASCII Video Terminal emulates the original Digital Equipment Corporation (DEC) VT100 video terminal shown here.

This is an example of the cheap composite monitors that are available (this one cost $19). They are normally used with vehicle reversing cameras but they also work great as a graphics display for a microcontroller using the ASCII Video Terminal microcontroller as the video processor.

pre-programmed chip from the SILICON CHIP On-line Store.

As shown on Fig.1, IC1 produces separate output signals for VGA video and *composite* video. Since separate resistive divider networks set the video levels, this means that it can provide an optimal display, regardless of which output you are using.

At power up, the firmware first checks if a VGA monitor is connected. That's done by measuring the impedance of pin 12 of IC1 to ground – if it's less than 2kΩ, there must be a VGA monitor connected and the firmware configures itself to drive this monitor. Otherwise, it assumes that a composite monitor is attached and it configures itself to drive this type of monitor.

Note that you should not connect both types of monitor simultaneously.

VGA output

The video signal is generated using a similar approach to that used in the Maximite series of computers. First, the video is written as a bitmap to a bank of memory. Then, using DMA (Direct Memory Access) and an SPI interface, the series of bits (pixels) are streamed from the memory to the monitor. The output is monochrome (just like the original VT100).

A full scan line from the VGA output is 480 pixels wide which displays perfectly on an old-fashioned CRT monitor. On an LCD monitor, the character formation is not as good due to the monitor having to map this output to its native resolution. The result is perfectly legible and usable but you do get the best image with a CRT monitor.

The default display is 24 lines x 80 characters wide, which is the VT100 standard. Alternatively, by using the Set-Up menu (more on this later) or by sending the correct escape code, you can switch the display to 36 lines x 80 characters wide if you wish.

For VGA, the horizontal and vertical sync outputs are directly connected to the monitor which accepts standard TTL signalling levels. The video signal is different and is limited to a maximum level of 0.7V. This is achieved by connecting a 220Ω resistor in series with the 75Ω input impedance of the monitor.

You can select the colour of the text on the monitor by bridging one of three sets of solder pads (SELECT COLOUR) in series with the VGA socket on the PCB. These are marked GRN, BLU and RED, ie, for green, blue and red. We chose green, as many ASCII terminals from that era used a green phosphor and the colour is soothing to the eye.

You can select more colours by bridging two sets of pads (eg, green and red will give yellow). However, this will have the effect of halving the input impedance of the VGA monitor (as seen by the ASCII Video Terminal) and so the 220Ω series resistor should be reduced to 165Ω to compensate (ie, use two 330Ω resistors in parallel).

The limiting factor is the output drive capability of the microcontroller which must not exceed 15mA. With

one colour and a 220Ω resistor, the peak current is 10mA. With two colours and 165Ω, it is 14mA which is just within the chip's specification.

If you select two colours, the display will be not as bright as for a single colour and you will be pushing the chip close to its limit. For these reasons, we recommend sticking with one colour (eg, green).

Composite video output

The composite video output is generated in a similar manner to the VGA output but with different timings. Another difference is that the video and sync signals are summed via 150Ω and 470Ω resistors in conjunction with the 75Ω input impedance of the monitor to give the correct composite voltage levels.

By default, the composite output uses PAL timing (ie, 625 lines) which gives a display of 18 lines x 50 characters wide. You can also select NTSC timing via the Set-Up menu and in this mode it displays 15 lines x 50 characters. In both cases, the output is monochrome (black and white).

Composite mode is especially useful when used with cheap monitors intended for use with reversing cameras on trucks and cars. They come in a variety of sizes and prices but a small 4.3-inch monitor can be bought cheaply on eBay (ours cost just US$19). This display can be mounted on the front of an instrument case and can show an amazing amount of information, including graphics – all driven by a Micromite or PICAXE.

On such a small screen, the standard font can be hard to read so the ASCII Video Terminal has two extra fonts which can be selected by sending the appropriate escape codes. These give extra large letters that really stand out, even on a 4.3-inch screen.

Serial interface

Connector CON1 is the serial data interface for the ASCII Video Terminal, with pins 2 & 3 going to the RxD (receive data) and TxD (transmit data) lines respectively. As shown, the RxD line is fed to pin 5 of IC1 and is pulled high via a 100kΩ resistor to prevent it from floating if it is not connected to anything. The 10kΩ resistor in series with pin 5 provides protection when the input is connected to a circuit that uses signalling voltages above 3.3V.

Pin 4 of IC1 is the TxD output and is directly connected to the external device via CON1. The serial connector also provides a +3.3V output and a ground connection. The 3.3V connection can be used for powering other circuitry such as an RS232 converter or a Micromite and can supply a maximum of 100mA.

The voltage levels used in the serial interface are TTL which means that idle is voltage high, the start bit is voltage low, data uses a voltage high for logic 1 and the stop bit is voltage high. You can also use RS232 signalling but more on that later.

Setting the baud rate

The baud rate is set by sliding shorting plugs over pairs of pins on jumper block J3. The table in Fig.1 shows the various baud rates that are available. This method makes it easy to select standard baud rates from 1200 to 115,200 bits per second (bps).

Note that the baud rate is set when the ASCII Video Terminal is powered up, so if you change a jumper you will have to cycle the power for it to be recognised.

The baud rate selected when there are no shorting plugs installed is slightly different – by default it is 1200 bps but this can be changed in the Set-Up menu to anything from 40 bps to 1,000,000 bps (yes, that is a baud rate of one million bits per second). You are not just restricted to the standard baud rates (1200, 2400, etc); instead, you can set any speed that you require. For example, you could set the speed to 2222 bps if you wished.

This arrangement gives you the best of both worlds. You can either select a range of standard baud rates using jumpers or you can configure any other non-standard speed via the Set-Up menu. Using this menu, you can also select other options, including parity (odd, even or none), the number of data bits and the number of stop bits.

The processing required to convert each character to a bitmap (ie, for the video display) limits the sustained speed that the terminal can handle to about 44,000 bps. To offset this, the firmware uses a substantial input buffer that can store incoming characters while the preceding characters are processed.

Most systems only send a block of data at a time (ie, a screen full of characters) because the user would not have the time to read the data otherwise. The Micromite is the same; the editor only displays one screen of characters, then waits for further user input. With its large input buffer, the ASCII Video Terminal can handle very

Main Features

- Single chip ASCII Video display terminal with VT100 and VT52 emulation.
- VGA or Composite Video (PAL or NTSC) output with automatic switch over.
- VGA can display 24 lines x 80 characters or an extended resolution of 36 lines x 80 characters.
- Composite video can display 18 lines x 50 characters (PAL) or 15 lines x 50 characters (NTSC).
- Standard PS/2 compatible keyboard input with support for standard US keyboard layout or French, German, Italian, Belgian, Russian or United Kingdom keyboard layouts.
- TTL or RS232 serial input/output. Baud rates from 40 to 1,000,000bps with odd, even or no parity and one or two stop bits.
- USB input with serial emulation – can be used as a USB to serial converter.
- Extended VT100 terminal emulation. Extensions include graphics codes for drawing lines, boxes and circles (which can be hollow or filled).
- Graphics resolution is 480 x 288 pixels in VGA 25 line mode, 480 x 432 pixels in VGA 36 line mode, 304 x 216 in PAL composite and 304 x 180 pixels in NTSC composite mode.
- Three inbuilt fonts (standard, large and jumbo) and four character attributes (normal, underline, reverse and invisible).
- Power requirement: 5V at 50mA plus any current drawn from the 3.3V pin on the serial connector.

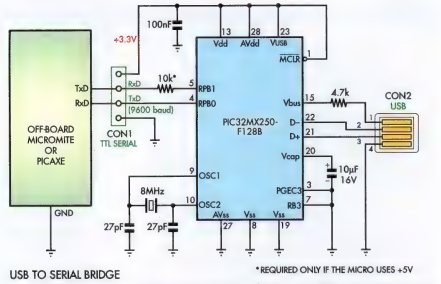


Fig.2: if all you need is a USB-to-Serial bridge, you can strip the circuit shown in Fig.1 down to the configuration shown here. It can be built on the PCB used for the full ASCII Video Terminal or on a piece of scrap stripboard.

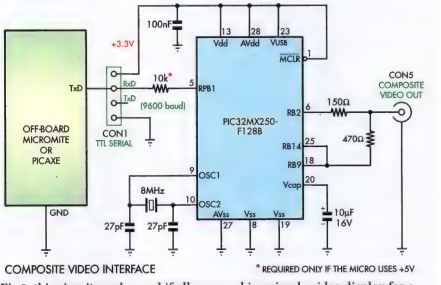


Fig.3: this circuit can be used if all you need is a simple video display for a project. It could be used to drive a low-cost 4.3-inch composite monitor as used with vehicle reversing cameras

high speed data transmissions without losing any characters.

RS232

RS232 is a serial signalling standard that's similar to the TTL signalling used here. The difference is that, for RS232, the polarity is inverted and the voltage levels swing from -12V to +12V. RS232 is used in PC serial ports, older modems, test equipment and the original VT100 terminal.

The "correct" way to connect an RS232 device to the ASCII Video Terminal to is to use an RS232-to-TTL converter such as the one shown in the above photo. These don't cost much and generally use a Maxim MAX232 or MAX3232 chip which generates the required signalling voltages internally.

However, you can directly connect an RS232 device to the ASCII Video Terminal if you wish. That's because the 10kΩ resistor in the RxD (receive data) line will protect the PIC32 from the high voltage swing. In addition, most RS232 devices have a threshold of about +1V when detecting if a signal is high or low and so data from the PIC32, with its output of 0-3.3V, will be detected as a valid signal.

Basically, all you need to do is go into the Set-Up menu to invert the signal polarity of the serial interface and then you can directly connect an RS232 device. This arrangement does violate the RS232 rules but it should work fine for short cables up to a metre or two. **On the other hand, if your cable run is much longer, then you should use an RS232-to-TTL converter as that will provide a far better level of immunity from electrical noise.**

The ASCII Video Terminal can be used directly with most RS232 sources but if you want a fully-compliant RS232 interface you should purchase one of these. It's an RS232 converter that can be powered from the terminal and will drive the serial signal over long lines. They're available for just a few dollars on eBay.

Keyboard interface

The keyboard input is via a standard IBM PS/2 connector. Keyboards with this connector are becoming harder to find but they are still out there and generally very cheap. The keyboard input will also work with keyboards that are dual-standard USB or PS/2 (ie, those that come with a suitable adapter).

By default, the ASCII Video Terminal is configured to work with the standard US keyboard layout, as used in Australia and NZ. However, using the Set-Up menu, you can also select French, German, Italian, Belgian, Russian or United Kingdom layouts. Note that this does not include generating the special characters required by some languages.

All the standard keys on the keyboard will work, including the numeric keypad, Num Lock, Shift and Caps

Lock. And by sending the appropriate VT100 escape commands to the ASCII Video Terminal, a program can also independently turn the three LEDs (for Num Lock, Caps Lock & Scroll Lock) on the keyboard on and off.

Any keystrokes on the keyboard will be sent out on the TxD (transmit) line of the serial interface. This means that if you don't have the terminal connected to anything, then pressing keys will not show anything on the screen. This means that when testing the ASCII Video Terminal, the TxD and RxD lines on the serial interface should be bridged so that you can then see the results of your key presses on the screen.

USB

The USB interface emulates a serial COM connection over USB. This means that you can open a serial emulator on your computer and anything you type will be sent out of the ASCII Video Terminal's serial interface, just as if it was typed on its own keyboard. Similarly, anything received from the serial interface will be sent via USB to the computer.

You can easily add USB capability to a microcontroller with the ASCII Video Terminal or simply use it to act as a USB-to-Serial converter for a Micromite or PICAXE.

To use the USB interface on your Windows computer, you need to install the SILICON CHIP USB Serial Port Driver (available from the SILICON CHIP website). This will work with all modern versions of Windows and full instructions are included with the driver. The USB interface uses the standard CDC protocol and drivers are also available on the internet for the Mac and Linux operating systems.

Power supply

The circuit is powered from an external 5V DC supply and this can be fed in via the USB connector (ie, USB power) or via an external connector (CON3). If you wish to use USB power, you must install a jumper on JP2. **However, if you do this, make sure that you do not simultaneously apply power to the external power connector (CON3) as that could cause a conflict with the power supply from the USB host.**

The 5V supply is used by the keyboard and is also regulated to 3.3V by 3-terminal regulator REG1 which supplies the PIC32 microcontroller

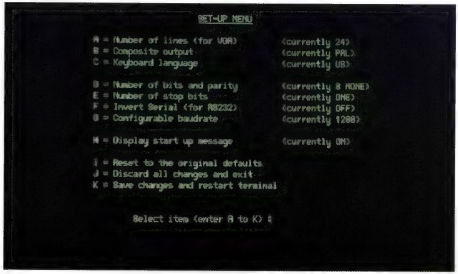


Fig.4: the Set-Up Menu is accessed by pressing Shift-F12 on the PS/2 keyboard. All changes are saved in the microcontroller's flash memory so they will be remembered even if the power is removed. Note that you must have a keyboard and a video display attached to access this menu.

(IC1). The specified regulator is a low drop-out device that will continue to deliver a stable 3.3V output even when the USB voltage is at the lower limit allowed by the USB standard (which is 4.5V).

The 10µF capacitor on pin 20 (Vcap) of the microcontroller deserves special comment. Its ESR must be less than 1Ω and that means that it must be a multilayer ceramic capacitor or a high-quality tantalum type. Some low-cost tantalums have an ESR higher than 1Ω so if you suspect that yours might fall into this category you should substitute a 47µF tantalum (which should be well within the limit).

The only other circuit item of note is the activity LED (LED1). This is illuminated after IC1 has completed its initialisation and this indicates that all is well with the chip. LED1 will also momentarily blink off whenever a keyboard key is pressed or a character is received on the serial or USB interface, indicating that activity is taking place.

Selecting functions

The ASCII Video Terminal can be interfaced to many different devices but that doesn't mean they all have to be used. You can leave off any function and the device will still perform the other functions. This includes the USB, the video output and the keyboard. None of these need to be connected if your particular application does not require them.

For example, if you just need a simple USB-to-serial bridge in a project, you could use the circuit shown in Fig.2. It uses only nine components including the USB connector and could be either be built on the ASCII Video Terminal PCB or built on a scrap of stripboard.

If you just need a simple display in a project, you could add a 4.3-inch graphic display using a low-cost composite monitor. The required circuit is shown in Fig.3 and uses just 10 components.

Set-Up menu

The Set-Up menu lets you specify a number of options which will be stored in non-volatile memory. This means that they are automatically recalled when power is applied.

You must have both a keyboard and a VGA or PAL composite monitor connected to the ASCII Video Terminal to access this menu. It's brought up by pressing Shift-F12 on the keyboard – see Fig.4.

We have covered most of the options that are available on the menu before, so we won't go over them again. The only new option is "Display startup message on/off".

By default, when the terminal starts up, it will display a message on the video output, showing the version number and copyright. If you don't want this, you can disable the message (just like on the original VT100).

VT100 emulation

We have mentioned VT100 emulation several times before but just what

ASCII Video Terminal Escape Codes

Note: codes surrounded by angle brackets (< and >; for example, <v> or <h>) represent one or more decimal digits

Auto-wrap mode off	ESC [?7l
Auto-wrap mode on (default)	ESC [?7h
Set 36 lines per screen	ESC [?9l
Set 24 lines per screen (default)	ESC [?9h
Set alternate keypad mode	ESC =
Set numeric keypad mode (default)	ESC >
Turn off all character attributes	ESC [m
Turn off all character attributes	ESC [0m
Turn underline mode on	ESC [4m
Turn reverse video on	ESC [7m
Turn invisible text mode on	ESC [8m
Select font #2 (large characters)	ESC [3m
Select font #2 (jumbo characters)	ESC [6m
Move cursor up n lines	ESC [<n>A
Move cursor down n lines	ESC [<n>B
Move cursor right n lines	ESC [<n>C
Move cursor left n lines	ESC [<n>D
Move cursor to upper left corner	ESC [H
Move cursor to upper left corner	ESC [;H
Move cursor to screen location v,h	ESC [<v>;<h>H
Move cursor to upper left corner	ESC [f
Move cursor to upper left corner	ESC [;f
Move cursor to screen location v,h	ESC [<v>;<h>f
Move/scroll window up one line	ESC D
Move/scroll window down one line	ESC M
Move to next line	ESC E
Save cursor position & attributes	ESC 7
Restore cursor position & attributes	ESC 8
Clear line from cursor right	ESC [K
Clear line from cursor right	ESC [0K
Clear line from cursor left	ESC [1K
Clear entire line	ESC [2K
Clear screen from cursor down	ESC [J
Clear screen from cursor down	ESC [0J
Clear screen from cursor up	ESC [1J
Clear entire screen	ESC [2J
Device status report	ESC 5n (response is ESC 0n)
Get cursor position	ESC 6n
Response: cursor is at v,h	ESC <v>;<h>R
Reset terminal to initial state	ESC c
Identify what terminal type	ESC [c
Identify what terminal type (another)	ESC [0c (response is ESC [?1;0c)
Turn off all three LEDs	ESC [0q
Turn on LED Num Lock	ESC [1q
Turn on LED Caps Lock	ESC [2q
Turn on LED Scroll	ESC [3q
Draw a line	ESC [Z1;<x1>;<y1>;<x2>;<y2>Z
Draw a box	ESC [Z2;<x1>;<y1>;<x2>;<y2>Z
Draw a filled box	ESC [Z3;<x1>;<y1>;<x2>;<y2>Z
Draw a circle	ESC [Z4;<x1>;<y1>;<r>Z
Draw a filled circle	ESC [Z5;<x1>;<y1>;<r>Z

VT52 Compatibility Mode Codes

Enter/exit ANSI mode (VT52)	ESC <
Enter alternate keypad mode	ESC =
Exit alternate keypad mode	ESC >
Move cursor up one line	ESC A
Move cursor down one line	ESC B
Move cursor right one char	ESC C
Move cursor left one char	ESC D
Move cursor to upper left corner	ESC H
Move cursor to v,h location	ESC <v><h>
Generate a reverse line-feed	ESC I
Erase to end of current line	ESC K
Erase to end of screen	ESC J
Identify what the terminal is	ESC Z
Response:	ESC /Z

VT100 Special Key Codes

These are sent from the terminal back to the computer when the particular key is pressed on the PS/2 keyboard. Note that the numeric keypad keys send different codes in alternate mode. See escape codes above to change the keypad mode.

UP	ESC [A	F3	ESC [13~
DOWN	ESC [B	F4	ESC [14~
LEFT	ESC [D	F5	ESC [15~
RIGHT	ESC [C	F6	ESC [17~
HOME	ESC [1~	F7	ESC [18~
INSERT	ESC [2~	F8	ESC [19~
DEL	ESC [3~	F9	ESC [20~
END	ESC [4~	F10	ESC [21~
PUP	ESC [5~	F11	ESC [23~
PDOWN	ESC [6~	F12	ESC [24~
F1	ESC [11~	F3+0x20	ESC [25~
F2	ESC [12~		

VT52 Special Key Codes

These codes are sent when the terminal is in VT52 mode. All other keys will generate the VT100 codes listed above.

UP	ESC A
DOWN	ESC B
LEFT	ESC D
RIGHT	ESC C

Fig.5: these are the codes that the terminal will respond to and will send when a special key is pressed. They emulate most of the functions on both the original DEC VT100 and VT52 terminals. Note that the symbol ESC means the escape code (decimal 27, hex 1B) and all codes start with this character. For a more detailed explanation of each code use Google to search for "VT100 User Guide".

does it mean in practice?

Basically, the original VT100 would accept many different codes to perform special functions such as clear the screen or position the cursor. The code would always start with the escape character which is '27' in decimal or '1B' in hex. It would then be followed by a number of ASCII characters which defined the function to be carried out. That is why they are called "escape codes".

You would be hard pressed to purchase a VT100 terminal these days (most are in museums) but its repertoire of escape codes has become a defacto standard and any serial terminal worth its salt will recognise VT100 codes. The ASCII Video Terminal implements most of these VT100 escape codes which means that it will work with any software that requires VT100 emulation.

Fig.5 lists the codes recognised by the ASCII Video Terminal. These include useful functions such as positioning the cursor, selecting reverse video, clearing the display, etc. There are also some less useful codes (such as set invisible text mode) but we implemented all that we could in the interests of compatibility.

For a more detailed explanation of each code use Google to search for "VT100 User Guide".

Note that all the escape codes start with the escape character which is shown in the table as "ESC" . To give you an example of how you would generate these codes, the following program fragment running on a Micromite will clear the screen:

```
PRINT CHR$(27)+"[2J";
```

The following code will then position the cursor at the top left hand position on the screen:

```
PRINT CHR$(27)+"[f";
```

In these examples, CHR$(27) generates the escape code and the "+" symbol joins it to the following characters. The semicolon at the end of the statement suppresses the carriage return and line feed characters which BASIC normally adds to the end of any print statement.

In addition, the ASCII Video Terminal adds some extensions to the VT100 standard. These include codes to select 36 or 24 lines per screen for VGA and the ability to select from two extra large sized fonts (large and jumbo). It also includes codes to draw lines, boxes and circles on the screen.

In the latter case, the terms "X1" and "Y1" refer to the starting position on the screen and "X2" and "Y2" refer to the ending position. In the case of a circle, "R" is the radius of the circle. All these variables are in pixels, with the top lefthand corner of the screen being X=0 and Y=0. X is the horizontal position and Y is the vertical, with both getting greater as you move away from the top left corner.

The overall resolution depends on the display mode and these are listed in the features box.

The following example demonstrates how to draw a circle with a radius of 100 pixels at the centre of the screen (which is at pixel 240 by 144 when in VGA 24-line mode):

```
PRINT CHR$(27)+" [Z4;240;144;100Z";
```

Fig.5 also lists the codes generated by the terminal when a special key is pressed on the keyboard. These keys include the arrow keys, function keys, Home and End. These codes are also preceded by an escape character and followed by 1-4 characters which indicate the actual key pressed. It is then up to the program running on the Micromite or PICAXE to interpret and act on these codes.

VT52 emulation

The VT52 terminal was the little brother to the VT100 terminal and recognised a more limited range of codes. These codes are also less complex than the VT100 codes and some software programs insist on using them, so we have also included support for these.

If you want to use VT52 codes, you can put the ASCII Video Terminal into VT52 mode by sending the code "ESC <". To exit this mode, you simply send the same code again.

The arrow keys on the keyboard generate different escape codes when in VT52 mode. Fig.5 also lists these codes.

Construction

The complete ASCII Video Terminal is built on a single PCB coded 24107141 and measuring 90mm x 51mm. It uses standard through-hole components (ie, no surface-mount parts), so construction is easy. If you wish to mount it in a box, the dimensions and mounting holes are sized to suit a standard ABS box measuring 120 x 60 x 30mm (Altronics H0216 or Jaycar HB6032).

Fig.6 shows the parts layout on the PCB. The first step is to decide what colour the text on the VGA monitor should be. This is selected by bridging one of three sets of pads with solder. This is best done first, as the jumper pads can be difficult to access once parts have been mounted.

Parts List

1 double-sided PCB, 90mm x 51mm, code 24107141
1 USB Type B socket, PCB mount (Jaycar PS-0920, Altronics P1307, element14 1696537) (CON2)
1 DE-15 (or HD-15) high-density 15-pin female D-connector (AMP 1-1734530-1, MULTICOMP SPC15430, element14 1557991 or 1564252) (CON6)
1 RCA socket, PCB mount (Jaycar PS0279, Altronics P0146A) (CON5)
1 6-pin mini DIN female socket, PCB mount (CON4)
1 28-pin DIL IC Socket
1 8MHz crystal (X1)
1 4-way polarised header, PCB mount, 0.1 inch pitch (CON1)
1 2-way polarised header, PCB mount, 0.1 inch pitch (CON3)
1 10-way snappable pin header, 0.1 inch pitch (CON7,JP1,JP2)
1 2 x 3 male pin header (JP3)
5 shorting blocks, 0.1-inch pitch

Semiconductors

1 PIC32MX250F128B-I/SP microcontroller programmed with 2410714A.hex (IC1)
1 Microchip MCP1700-3302E TO-92 voltage regulator (REG1)
1 red LED, 3mm or 5mm (LED1)

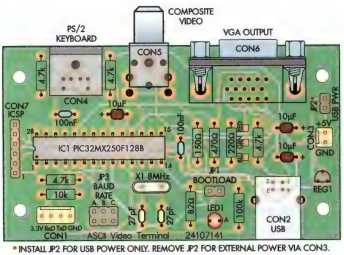
Capacitors

3 10µF 16V tantalum
2 100nF monolithic ceramic
2 27pF ceramic

Resistors (0.25W 5%)

1 100kΩ	1 220Ω*
1 10kΩ	1 150Ω
4 4.7kΩ	1 82Ω
1 470Ω	

* Replace with two paralleled 330Ω resistors if using two VGA colours.



* INSTALL JP2 FOR USB POWER ONLY; REMOVE JP2 FOR EXTERNAL POWER VIA CON3.

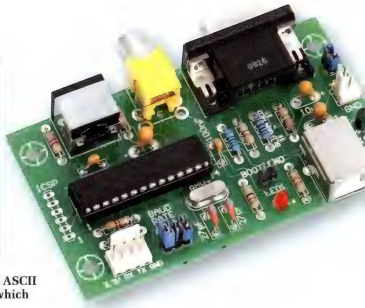


Fig.6: follow this diagram and the photo at right to build the ASCII Video Terminal. All the parts are mounted on a single PCB which makes it easy to incorporate into another project.

As previously stated, we recommend that you select the colour green, ie, by bridging the pads marked GRN.

It's then simply a matter of populating the board, starting with the low-profile components such as the resistors, the crystal and the capacitors. Leave the larger components such as the connectors until last.

Note that the crystal should be mounted 1-2mm proud of the PCB so that there is no danger of its case shorting on the solder pads. However, this is not strictly necessary if you are using a SILICON CHIP PCB because this will have solder resist covering the top solder pads.

Another point to note is that the footprint for the RCA socket will accommodate either a standard socket or a switched socket (the switching mechanism is not used). An IC socket should be used for the microcontroller as that will help with fault-finding and testing.

If you have a blank PIC32 microcontroller, the appropriate firmware should be downloaded from the SILICON CHIP website and programmed into it using a programmer such as the PICkit 3. The PCB includes a footprint for the ICSP (In Circuit Serial Programmer) header, so that you can program the microcontroller in-circuit.

Alternatively, you can purchase a microcontroller pre-programmed with the latest firmware from the SILICON CHIP Online Shop. In that case, the ICSP header can be left out. The PCB for this project is also available from the Online Shop.

The baud rate selection is done by slipping shorting links over pairs of pins on 6-pin header JP3 (see Fig.1). Alternatively, you could mount a 3-way DIP switch in place of the headers if you want to make it more convenient to change the speed.

Testing

The completed unit can now be tested by following this step-by-step procedure:

(1) Remove microcontroller IC1 from its socket.

(2) Apply power to the unit from a 5V bench supply or USB supply and check that +3.3V is present on pins 13, 23 & 28 of the IC socket.

(3) If the supply rail is correct, remove the power and install the microcontroller (make sure that it is orientated correctly).

(4) Reapply power and check that LED1 is illuminated. If so, this means that the microcontroller is correctly running its firmware and everything is OK in that department.

(5) Switch off, connect a keyboard and video monitor and then short the TxD & RxD pins on the serial interface connector (CON1).

(6) Reapply power and test the keyboard, monitor and serial interface by typing characters on the keyboard. You should see them echoed on the monitor via the serial interface.

(7) Leave the TxD to RxD short in place and connect the ASCII Video Terminal

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
27pF	NA	27p	27

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	4	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	1	82Ω	grey red black brown	grey red black gold brown

to a USB port on your PC using a suitable cable.
(8) Check that anything typed into your terminal emulator is echoed on both the monitor and on your computer's screen.

Fault finding

Fault finding is simple because the only significant component is microcontroller IC1. If the indicator LED illuminates, it means that the microcontroller has initialised and is working correctly.

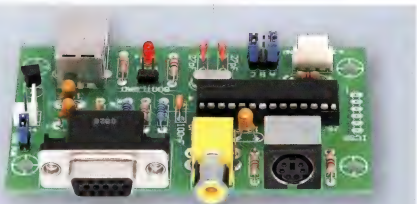
Conversely, if the LED doesn't light, check the power supply. If this is correct but the LED is still out, the fault must either be in the microcontroller, its programming or the 10µF capacitor attached to pin 20.

If the problem is associated with the keyboard or monitor, check the relevant parts carefully. For example, if the keyboard doesn't work, check your soldering around the PS/2 socket and any other parts associated with the keyboard.

Firmware update

There is always the chance that the firmware may contain a bug or we may later think of a feature that could be added. If so, we will make an updated version of the firmware available which you can load without a programmer.

Updating the firmware is easy to do (full instructions will be included with the update). To start the process, remove power, short jumper JP1 (marked BOOTLOAD on the PCB) and then reapply power. The firmware will then switch into update mode and will wait for the new firmware to be transferred via the USB interface.



This view shows the main I/O connectors. From left, they are the high-density 15 pin connector for VGA video, the RCA connector for the composite video output and finally the mini-DIN connector for a PS/2 keyboard. Note that only one video connector should be used at a time.

On your Windows PC, you then run a program (supplied with the update) to transfer the new firmware to the microcontroller. The whole process is quite painless and will take less than a minute. For firmware updates and handy hints, check the author's website at http://geoffg.net/terminal.html

So, there you have it. Your very own VT100-compatible terminal, ready to connect to your next creation. SC

Radio, Television & Hobbies: the COMPLETE archive on DVD

YES! MORE THAN A QUARTER CENTURY OF ELECTRONICS HISTORY!

This remarkable collection of PDFs ***covers every issue*** of R & H, as it was known from the beginning (April 1939 – price sixpence!) right through to the final edition of R, TV & H in March 1965, before it disappeared forever with the change of name to EA.

For the first time ever, complete and in one handy DVD, every article and every issue is covered.

If you're an old timer (or even young timer!) into vintage radio, it doesn't get much more vintage than this. If you're a student of history, this archive gives an extraordinary insight into the amazing breakthroughs made in radio and electronics technology following the war years.

And speaking of the war years, R & H had some of the best propaganda imaginable! Even if you're just an electronics dabbler, there's something here to interest you.

- **Every issue individually archived, by month and year**
- **Complete with index for each year**
- **A must-have for everyone interested in electronics**

Please note: this archive is in PDF format on DVD for PC. Your computer will need a DVD-ROM or DVD-recorder (not a CD!) and Acrobat Reader 6 or above (free download) to enable you to view this archive. This DVD is NOT playable through a standard A/V-type DVD player.

ONLY $62.00 +$10.00 P&P

Exclusive to SILICON CHIP

HERE'S HOW TO ORDER YOUR COPY:

BY PHONE:* (02) 9939 3295 9-5 Mon-Fri

BY FAX:# (02) 9939 2648 24 Hours 7 Days

BY EMAIL:# silicon@siliconchip.com.au 24 Hours 7 Days

BY MAIL:# PO Box 139, Collaroy NSW 2097

BY INTERNET:^ siliconchip.com.au 24 Hours 7 Days

* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. ^ You will be prompted for required information

Touch-Screen Digital Audio Recorder Pt.2

By ANDREW LEVIDO

Last month, we introduced our new Touch-Screen Digital Audio Recorder and described how it worked. This month, we will give the assembly details, provide some performance graphs and describe how the unit is used.

ALL THE PARTS for the Touch-Screen Digital Audio Recorder (except the battery) are mounted on a single PCB coded 01105141 (106 x 74mm). Most of these parts and the connectors are surface-mount types which are installed on the top side of the PCB. Only the microphone, touch-screen display and the SD card socket are located on the underside.

Don't be put off by the surface-mount nature of this project. With a little bit of care and patience, any reasonably experienced hobbyist can put this together in a few hours. As with any surface mount work, you will need a good work light, fine tweezers, a flux pen and a roll of solder wick. If you have some form of magnification (or a magnifying lamp), then so much the better.

Fig.6 shows the parts layout on the PCB. Begin with IC2 (LM3658). This is a 10-pin QFN (quad flat no-lead) package with 0.5mm pin spacing and a central thermal pad. Once you have successfully soldered this device in (as described below), you can consider yourself an SMD guru!

The technique is as follows: start by applying a small amount of solder to each of the 10 outer pads on the PCB. You want just enough solder to later re-flow under the pins but not so much that the pads are bridged or the chip does not sit flat against the board. Use solder wick to take off any excess if you have to.

Next, apply some liquid flux to the pads, then carefully position the chip so that it is centred horizontally and vertically with respect to the pads (take care to ensure that it is orientated correctly). Check that the pins, which are just visible on the sides of the chip, line up with the elongated pads. This is best done with the aid of a magnifying lens (or a microscope if you have access to one).

Once it's in place, hold the chip down using a pair of tweezers and apply your soldering iron to the elongated pads. Heat them just long enough for the solder you applied earlier to melt and re-flow under the pins. Add a small amount of solder during this procedure if necessary.

Once you have done this for all pins, flip the board over and melt a blob of solder into the four holes under the thermal pad. You will have to apply quite a bit of heat here, since the large rectangle of copper on the bottom side

is designed to be a heatsink. This step will not only solder the thermal pad but will also continue the re-flow process for the pads.

Alternatively, if you are lucky enough to have a hot-air rework tool, simply apply a little solder paste to the pads, position the chip and re-flow the solder with the hot air. Surface tension will help pull the chip into position if your placement was not perfect. This is a lot faster and less prone to errors than using a soldering iron, so if you do a lot of SMT work it is an investment worth considering.

Note, however, that once the chip is in place, you still have to flip the PCB over and melt solder into the holes under the thermal pad.

Microcontroller IC3 is the next on the list. Apply a generous amount of flux, then carefully position it on the pads (make sure it's correctly orientated) and tack solder a couple of pins on opposite corners. Now check that it's perfectly aligned and adjust if necessary before soldering the remaining pins.

Don't worry if you end up with a few solder bridges – you can clean these up later with solder wick.

The CODEC (IC1) can now be installed. With its 0.65mm pin spacing, it will seem positively huge compared to the last two chips. Use the same technique as for the microcontroller.

Regulator REG1 is the easiest of the lot. Once it's in, install the four SOT-23 Mosfets and then the passive SMDs (ie, the resistors and capacitors). These are 0805 size and so are fairly straightforward to solder by hand. Take care here because the capacitors are not marked and it's easy to mix them up.

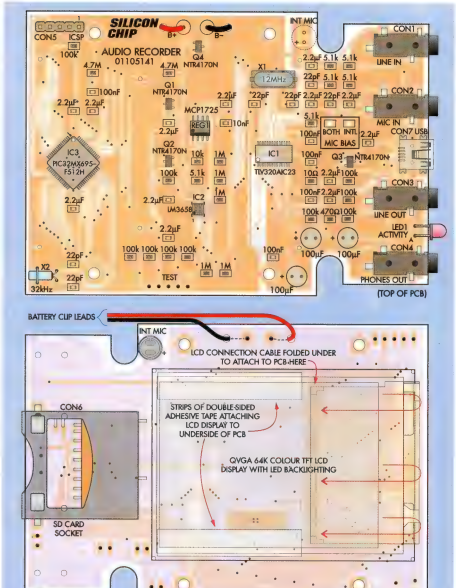


Fig.6: install the parts on the PCB as shown on these layout diagrams. The three SMD ICs and regulator REG1 go in first (see text), followed by the passive SMDs (resistors & capacitors) and then the larger through-hole parts. The LCD, SD card socket and internal microphone are mounted on the underside of the PCB, as shown in the bottom layout.

Microphone bias

You must now decide if you want the microphone bias to be available to the external microphone. If you do, install a link in the position marked "BOTH" (near CON2); otherwise install a link in the position marked "INTL". You can either use a 0Ω (0805) resistor (as we have) or just bridge the pads with a blob of solder.

Next, install the USB connector (CON7). First, place it on the board (make sure that the locating pins go into their holes) and solder the four mounting tabs. You will have to apply a fair bit of heat to get the solder to take to these. It's then just a matter of soldering the five pins. These protrude just enough from back of the connector to get at with a soldering iron.

Follow with the four 3.5mm audio jacks (CON1-CON4), then fit the through-hole electrolytic capacitors and the two crystals (X1 & X2). We used one of the capacitor lead offcuts to make a small strap to hold the 32kHz (X2) crystal in place.

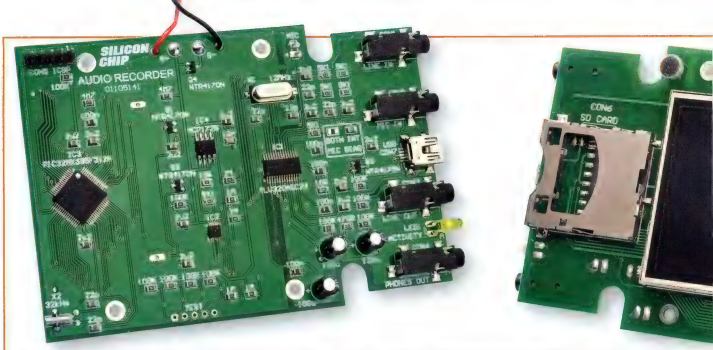
It's a good idea to also solder two more lead offcuts to the pads on the back of the electret microphone insert. This makes it easy to install later on.

The final step for this side of the board is to mount the ICSP header (CON5) if you intend to program the micro yourself. There's no need to mount the test header – it was used during development as a handy way to get access to the data traffic between the micro and the SD card.

SD card socket & LCD

As stated earlier, the SD card socket and the touch-screen LCD are mounted on the underside of the PCB (see Fig.6).

Start with the SD socket (CON6), as it's difficult to get to some of its pins once the LCD is installed. This socket shares its locating holes with two of



These views show the assembled PCB. The touch-screen LCD is installed by first soldering its ribbon cable to its PCB pads, then folding the LCD over this cable and securing it using strips of double-sided adhesive tape (see Fig.6).

the audio jacks. There are four pads to solder around the outside and 11 on the inside.

Mounting the LCD involves soldering its flexible ribbon cable to corresponding pads on the underside of the PCB. The two 1mm holes at either edge of the ribbon are used to line everything up. Take a minute or two to familiarise yourself with the correct orientation of the display before soldering any pads; it should be positioned such that it can fold back over the ribbon cable to face up as shown in Fig.6.

To install it, first peel the cover paper off the strip of double-sided sticky tape on the ribbon (not the strips on the back of the display). That done, line up the two 1mm holes in the ribbon with their corresponding holes in the PCB (we used a couple of 1mm drill bits to make this easy), then press down on the ribbon to fix it onto the PCB with the tape

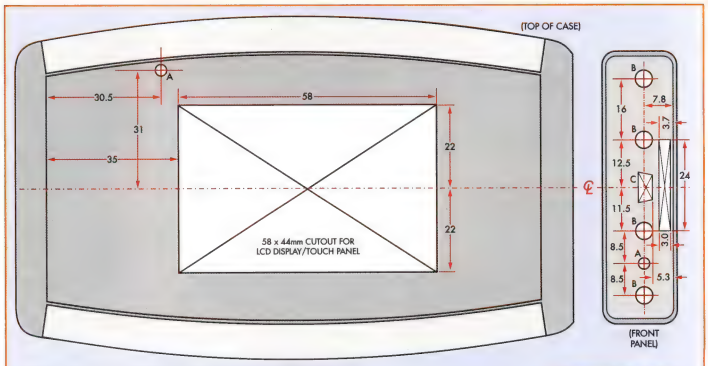
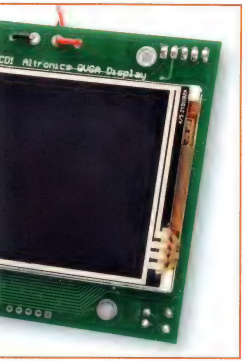


Fig.7: follow this diagram to make the display cutout in the case lid and to drill and cut the holes in the end panel. The display cutout can be made by drilling a series of holes around the inside perimeter, knocking out the centre piece and filing the job to a smooth finish. Hole 'A' at top left is for the microphone.



The ribbon cable can now be soldered to the pads. Work quickly here, as the ribbon will melt if you apply too much heat. We found it best to press the ribbon down onto the PCB with a probe, then solder three or four pads at a time, moving progressively along the ribbon.

Once the soldering is complete, fold the display over the ribbon and secure it to the PCB using the two strips of double-sided adhesive tape on the back of the panel. During this process, make sure that the LCD panel's four plastic posts (one at each corner) drop into their locating holes in the PCB.

Now fit the electret microphone insert (ie, with the wire leads soldered to it) to the PCB, observing the polarity. Don't solder it yet though; instead, position the PCB in the top half of the case and temporarily fix it there with a couple of mounting screws. That done, push the microphone down until its face is flush with the inside of the case, then solder its leads and trim off any excess.

The PCB assembly can now be completed by soldering the battery clip leads to the battery terminals (marked B+ & B-). Be sure to loop these leads through the strain relief holes as shown in Fig.6.

Preparing the case

Now turn your attention to the case. First, carefully mark out the LCD cut-out and the microphone hole on the lid as shown in Fig.7. That done, cut out the rectangular hole for the LCD and clean up the edges using a fine file. We chamfered the edges of the cut-out to improve its appearance, as shown in the photos of the unit.

Next, drill the 3mm-diameter hole for the microphone, then mark out and drill the end panel according as shown in Fig.7. Alternatively, you can simply attach the end-panel diagram to the panel and use it as a drilling template.

The cut-outs for the USB socket and the SD card socket can be made by drilling a series of very small holes, joining them up and then filing the job to shape. Once completed, test fit the panel to the PCB – you may need to fettle the socket openings to get everything to line up nicely.

Be careful when drilling and cutting out this end panel. There are a lot of connectors in a very small space, so there is almost "more hole" than panel.

Once everything is correct, fit the front panel to the PCB and then insert the assembly into the top section of the case. Secure the board with four short self-tapping screws, then fit two of the supplied battery terminals into the bottom half of the case. Solder the battery wires to these terminals, making sure that the positive lead goes to the positive terminal and the negative lead goes to the (spring-loaded) negative terminbal.

We used a piece of foam to fill the open space in the left-over battery position, so the cell cannot move.

Testing & Troubleshooting

Now for the smoke test! The step-

Parts List

1 double-sided PCB, code 01105141, 106 x 74mm
1 black hand-held ABS case with battery compartment, 89 x 147 x 25mm (Altronics H8986)
1 12MHz HC-49/US SMD crystal (X1) (Altronics V2267, element14 1842280, Digi-Key 535-10218-1-ND)
1 32.768kHz watch crystal (X2)
1 3mm orange or red LED (LED1)
1 QVGA RGB LCD touch-screen with LED back-light and controller (Altronics Z7080)
4 3.5mm switched SMD stereo jack sockets (CON1-CON4) (Digi-Key CP-3524SJCT-ND)
1 5-pin header (CON5) (optional, for in-circuit programming)
1 push-push SD card socket (CON6) (Altronics P5720 or equivalent)
1 SMD mini-B type USB connector (CON7) (Altronics P1308, element14 1507528, Digi-Key 151-1206-1-ND)
1 electret microphone insert (MIC1) (Jaycar AM4008)
4 No.4 x 6mm self-tapping screws
1 short length light duty red hook-up wire
1 short length light duty black hook-up wire
1 3.6V Lithium-ion AA cell
1 AA cell sized piece of non-conductive foam
1 SD/SDHC/SDXC card
1 USB type A to mini type B cable
1 short length double-sided tape

Semiconductors

1 TLV320AIC23 96kHz audio CODEC IC (IC1) (element14 1575048, Digi-Key 296-26817-1-ND)
1 LM3658SD Li-ion battery charger IC (IC2) (element14 1312584 or Digi-Key LM3658SD/NOPBCT-ND)
1 PIC32MX695F512H SMD microcontroller programmed with 0110514A.HEX (IC3)
1 MCP1725-3002E/SN LDO 3.0V regulator (REG1) (element14 1851958 or Digi-Key MCP1725-3002E/SN-ND)
4 NTR4170N SMD N-channel SOT-23 Mosfets (Q1-Q4) (element14 1887064 or Digi-Key NTR4170NT1GOSCT-ND)

Capacitors (all SMD 2012 size [0805 imperial] unless specified)

3 100µF 6.3V electrolytic
13 2.2µF 16V X7R ceramic
5 100nF 50V X7R ceramic
1 10nF 50V X7R ceramic
6 22pF 50V C0G/NP0 ceramic

Resistors (all SMD 2012 size [0805 imperial])

2 4.7MΩ	6 5.1kΩ
5 1MΩ	1 470Ω
10 100kΩ	1 10Ω
1 10kΩ	1 0Ω

Where to buy a kit: a kit of parts will be available for $139.95 from Altronics (Cat. K 5530). It will have SMDs IC1-IC3 pre-soldered to the PCB.

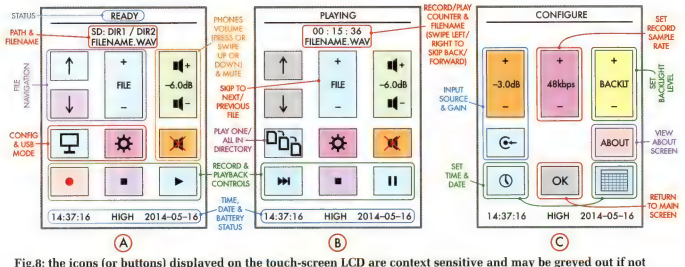


Fig.8: the icons (or buttons) displayed on the touch-screen LCD are context sensitive and may be greyed out if not relevant to the current function. There are three main status screens: READY, PLAYING and CONFIGURE.

by-step procedure is as follows:

(1) Connect a bench power supply set to deliver 4V to the battery terminals (ie, without the battery installed). Be sure to get the polarity correct and if your supply has current limiting, set this to around 500mA.

(2) Apply power and check that the LCD lights up and displays the various menus and icons. Of course, this assumes that you purchased a pre-programmed micro. If the micro didn't come pre-programmed, now is the time to program it.

(3) Once you have a working micro, insert an SD card and check that you can move through the directories, play audio files and make a recording using the internal microphone.

(4) If that checks out, remove the power supply, insert a battery and check that it begins to charge when the unit is connected to a USB port on a PC.

(5) Press the USB button and verify that the audio recorder appears as an external drive on the PC.

If this all checks out, you are ready to start using the Touch-Screen Digital Audio Recorder. If you do have problems, work logically to isolate the cause. If the display is black, for example, check the 3V rail and 12MHz clock to make sure these are OK, since the micro can't run without them.

If the 32kHz oscillator is working, then you can be sure the micro itself is OK, so look for problems with Mosfets Q1 & Q2 and for soldering issues on the LCD ribbon cable and the corresponding pins on the micro.

If the display works but you can't read an SD card, check the components and soldering in that part of the circuit. Make sure that the SD card is formatted correctly and try an alternative card if there are still problems. Similarly, if there is a problem with the audio, check the circuitry around IC1.

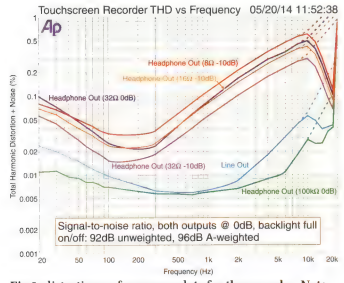


Fig.9: distortion vs frequency plots for the recorder. Note that since the headphone output performance (at 0dB) into a high impedance is better than the line output, there's little reason to use the line output. We had to use a 20kHz low-pass filter for these measurements so distortion above 10kHz is understated; the dotted lines indicate our guess as to the real performance.

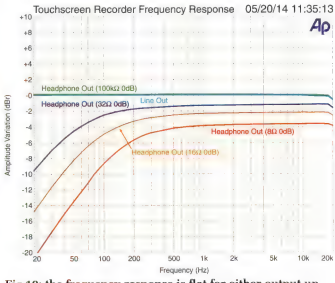


Fig.10: the frequency response is flat for either output up to 18kHz into a high-impedance load. However, the low-frequency roll-off is significant when driving headphones (typical 16Ω headphones/ear-buds have a -3dB point of 100Hz). Note that bass performance could be improved by increasing the value of the two 100µF electrolytic coupling capacitors to 470µF.

If the activity LED pulses steadily while playing and recording, you can be reasonably sure that the problem lies with the CODEC or its surrounding circuitry. Any problems are most likely to be caused by incorrectly positioned parts, solder bridges or missed/faulty solder joints.

Using the recorder

The Touch-Screen Digital Audio Recorder is fairly intuitive to use. Most of the time, the user interacts with a single screen like that shown in Fig.8A. The "buttons" are context sensitive and may be greyed out if they are not relevant for some reason. For example, as shown in Fig.8A, the Stop button will be greyed if there is nothing playing or recording.

A status bar is shown at the top of the screen and immediately below that are two lines of text (eg, to indicate the directory path and filename). In addition, the current time and date are displayed at the bottom of the screen, along with the battery charge/discharge status.

The READY status in Fig.8A indicates that an SD card has been successfully mounted. The file navigation keys can then be used move through the directories and files on the card. The file "rocker" moves through the entries in the current directory.

The current entry (eg, a filename) is displayed on the lower of the two text lines and the path is shown on the upper line. If the current entry is a directory, the down arrow allows a sub-directory to be selected. Similarly, the up arrow button allow you to move up to the parent directory, if you are currently below the root directory.

Immediately below the file navigation area are buttons to jump to the configuration screen and to put the recorder into USB mode. MSD mode allow the files on the recorder to be read on a PC via the USB port. To the right of this are the headphone volume control and the output mute button.

The bottom row of buttons control the record and playback functions. Pressing the record button creates a new file and begins a recording, while pressing the Play button opens and plays the selected file. Once playing, the screen changes slightly to that shown in Fig.8B (the record screen is similar).

At the same time, the status changes to PLAYING and a counter replaces the path name. In addition, the file navigation and USB mode buttons are disabled and the play/record controls change as shown.

The action of the Pause button is fairly obvious – it toggles between pause and resume on alternate presses. The Skip button stops playing the current file and skips to the next one in the directory. When recording, the Skip button closes the current file and immediately opens another and carries on recording into that.

Fig.8C shows the configuration screen. It's entered by pressing the Configuration button on the main screen. At the top left is the line input gain rocker, while immediately below that is the input source selector. Pressing this repeatedly rolls through the three options: line input, mic input and mic input with 20dB extra gain.

At top centre is the record sample rate selector and to its right, the backlight level control. Any change to the sample rate applies from the next recording. The About button displays the software version information (as you might expect) while the OK button returns control to the main screen.

Either side of the OK button are buttons that allow setting of the time and date. If an error occurs at any time, a message is displayed at the top of the screen along with an Acknowledge button to dismiss it. The error message gives the reason for the error and a code indicating which part of the software was responsible.

If a catastrophic error occurs, the activity LED will flash an error code. These error codes correspond to the processor exception codes except for a double flash that indicates the event queue has overflowed. These errors should never happen under normal circumstances and a full reset is the only way to recover.

You can explore the rest of the user interface yourself and even attempt some software modifications of your own if you are so inclined. SC

The PCB is secured to integral mounting posts inside the case using four self-tapping screws.

ALTRONICS

Build It Yourself Electronics Centre

Issue: July 2014

Winter Savers

New online shopping experience at www.altronics.com.au

Bring 3D Prototyping to your desktop!

Manufactured in Europe by renowned kit maker Velleman, this superbly designed 3D printer allows you to create your own 3 dimension prototypes and designs at home. It features a 200 x 200 x 200mm build area with heated print bed and uses PLA or ABS 3mm filament. The tubular frame construction is simple to put together and leaves plenty of scope for modification if you so desire! • Excellent support from Velleman service forum • Fully upgradeable as new software & firmware is released • Includes power supply • Includes ALL parts, no need to buy anything else. Build it and print! **Check the website for comprehensive specs.**

Optional Add Ons:
K 8230 Control module with LCD & SD card slot: **$149**
K 8234 LED lamp for a clear view of printed objects: **$34.95**

Filament Reels	Black	Grey	White	ONLY:
PLA 1kg/5m	K 8210	K 8213	K 8215	$44.95
ABS 1kg/5m	K 8220	-	K 8223	$42.95

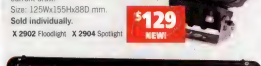
In Stock Now!

$1299
Now Available!

New 4WD Lighting Range

Tough 40W CREE® LED Lamps
IP68 weatherproof vehicle lamps housed in a diecast powdercoated case. 2800 lumen output. 304 grade stainless hardware with durable UV stabilised flyleads. 9-40V DC, 3A current draw.
Size: 125Wx155Hx88D mm.
Sold individually.
X 2902 Floodlight **X 2904** Spotlight

$129 NEW!



100W CREE® LED Light Bar X 2906
This superbly constructed 100W bar features ten CREE® LEDs. Great for mounting on utility bars, roof racks etc on 4WDs and boats. 7500 lumens output. 304 rated stainless steel bolts and adjustable aluminium mounting brackets. 9-48V dc operation, 6.25A current draw (12V). Size: 443W x 64H x 92Dmm. **Sold individually.**

$399 NEW!

D 2811

$159 NEW!

Turn your 'dumb telly' into a smart telly!
Smart TVs are all the rage - allowing you to stream movies, music and photos to your big screen, plus access an array of smart phone style games & apps. Simply plugs into a spare HDMI input. Streams 1080p HD video over wireless connection. 1GB of RAM, 4GB memory & micro SD slot.

Wireless sound anywhere your want it!
This wireless speaker uses the latest Bluetooth 4.0 standard with quick NFC device pairing with your smartphone or tablet. 40mm compact speaker and tuned enclosure • Hands-free phone functionality.

$54.95 NEW!

D 2036

1W torch with weatherproof case!

X 5100

$79.95 NEW!

NEW Bluetooth® Speaker & Torch
Listen to music on the go! Wireless music streaming combined with a torch/bike light with flash mode. Built in mic allows hands free phone calls. Great for fishing too!

Marine 25W LED Flood Lamp
Housed in a stylish diecast white powdercoated case this 1800 lumen flood bean CREE® LED is the perfect addition to your boat. UV stabilised flyleads with 304 rated stainless steel hardware. 9-32V DC operation. 2A current draw. Size: 1066 x 91D mm. **Sold individually.**

$139 NEW!

X 2900

Add an A 1004 Wireless Keyboard & Trackpad Remote for just $50 with any D 2811. Valued at $115 RRP

BONUS BUY!

2 Channel DJ Mixer
Great for beginners and mobile DJs requiring a robust lightweight mixer. Two pairs of switchable phono and line inputs, plus stereo record and amp outputs. Bass, treble and gain adjustments. Cue crossfader makes it easy to cue upcoming tracks. Includes power supply.

A 2544

$109 SAVE $20

D 2325

$69.95 NEW!

NEW Qi 'Cable Free' Charging Pad
A slimline 3 coil charging pad for phones equipped with Qi charging (or those fitted with a Qi case). Just put your phone on the pad and it charges instantly!

Compact 10W LED Work Lamp
A great addition to the 4WD for beach fishing or exterior lighting for caravans, heavy machinery and trucks. 570 x 65Dmm.Weatherproof (IP67 rated) diecast case. Features a 720 lumen CREE® LED element. Durable UV stabilised flylead. . 9-60V dc operation, 750mA current draw.
Sold individually. X 2908

$44.95 NEW!

Our Build It Yourself Electronics Centres...

» **Springvale VIC:** 891 Princes Hwy » **Auburn NSW:** 15 Short St » **Perth WA:** 174 Roe St
» **Balcatta WA:** 7/58 Erindale Rd » **Cannington WA:** 6/1326 Albany Hwy

Phone Order Now On...
1300 797 007
or shop online 24/7 at www.altronics.com.au

New DC Power Wallplates

Virtually any combination you may require in car accessory socket, Merit socket and 2.1A 5V USB charging. Each plate is supplied with two facia covers to suit your existing wallplates. Easy connection via 6.3mm spade lugs on rear.

L 1042

Merit & USB Charging Plate. $42.50 NEW!

L 1043

Car Acc. & USB Charging Plate. $42.50 NEW!

L 1037

Dual Car Accessory Plate $24.95 NEW!

L 1044

Dual Merit Socket Plate $29.95 NEW!

L 1041

Merit Socket & Car Acc. Plate. $24.95 NEW!

L 1036

Car Acc. Socket & TV Aerial Plate $22.50 NEW!

Top Quality Power Accessories

Benchtop space savers!

M 8303 0-30V 3A $159 NEW!

M 8305 0-30V 5A $189 NEW!

Compact & Efficient Lab Power Supplies

Price breakthrough! These quality units are great for servicing, repair and design of electronics. Low noise switchmode design. Fine/coarse voltage and current controls. Size: 89Wx160Hx205Dmm.

Now with USB output!

$39 SAVE 12% M 8070A

240V Power From A Cup Holder!

Provides 240V power for charging laptops, small tools, lamps, chargers and more! 150W rated (450W surge). Ideal for camping. 12V input. 60mmØ. Modified sine wave.

$24.50 NEW! M 8893

Surge protected outlets!

$29.50 NEW! M 8894

3.5A Dual USB Mains Chargers

With pass through 240V socket so you don't lose an outlet! Great for keeping your phone & tablet charged. Mains surge circuitry protects your appliances from damaging power fluctuations.

$27.95 NEW! M 8885

HPM® Dual 4.2A USB Charger

Dual 2.1A USB outputs for charging two tablets at once. Fitted with 1m mains lead for easy connection on your desk or table.

High Power Compact Pure Sine Wave Inverter

Ideal For 4WDs & Caravans!

Pure sine wave 12V inverter with high 800W surge rating suitable for powering difficult loads, including switchmode power supplies. Fitted with USB charging output. 400W rated. Size: 200L x 108W x 60Hmm.

Pure Sine Wave

$239 NEW MODEL! M 8012A

Complete protection & power backup UPS systems.

Provides power backup when mains fails, plus added protection for surges and spikes on power, phone & data lines. Backup time for 4 ch. CCTV system: 17mins. **2 year warranty.**

Protection For:
Computers
Home Theatre
CCTV Systems
Security & Alarms

Includes monitoring & shutdown software

D 0882A 1200VA $250 SAVE $25

D 0883 1600VA $325 SAVE $50

Suits temporary or permanent install

N 0706 $78 SAVE 14%

15W Portable Solar Panel Charger - FREE power anywhere you travel!

Provides up to 1A charge current for keeping car, caravan or 4WD batteries topped up. Ideal for portable situations where temporary charging might be needed, such as campsites. Includes croc clips and car accessory plug. Size: 977Lx342Wx22Dmm.

$44 SAVE 20% M 8627A

Laptop & USB Car Charger

This compact supply simply plugs into a car accessory socket & provides regulated power to a laptop. Selectable voltages: 15, 16, 18, 19, 20, 22 and 24VDC, up to 120W. Supplied with 8 adaptors to suit most laptops.

N 2080

Great for portable solar systems

$62 SAVE 17%

Keep an eye on your solar power

Great for measuring and monitoring PV solar system output. Connects inline between any DC power source and connected load. Logs Amp hours, Watt hours, current, min & max voltages. 5-60V 20A. Optional USB datalogger module $84.95 (N 2081).

N 2104 $89 SAVE 25%

100A Electronic Battery Isolator

Allows you to connect a load (such as a camping fridge) to one battery whilst ensuring the second battery remains charged for starting the engine. Full electronic isolation for use in modern cars.

$28 SAVE 15% A 0288A

Top Value Home Battery Charger

Charges four AAA/AA/C/D or two 9V cells!

A great way to keep batteries charged up for any appliance. Four charging bays with LEDs. Suits NiCAD or NiMH cells. 240V mains. Batteries not included.

Latest Test Equipment

Pay less for top quality tools & test gear!

Amazing True RMS Meter for under $30!

An affordable true RMS digital multimeter for the enthusiast or technician. The benefit of true RMS is increased accuracy when measuring ac voltages. Packed with other features too, including a 2MHz frequency counter, capacitance up to 2000µF, data hold, auto power off and an easy read 2000 count backlit LCD.

$29.95 NEW!

Q 1070

Autoranging DMM with non-contact detection.

No need to switch ranges all the time! Includes a non-contact voltage detector for identification of live wires. An affordable, versatile meter designed for the electronics enthusiast or handyman. 20A current range. Data hold. Backlit LCD.

$34.95 NEW!

Q 1134

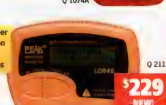
Autoranging True RMS DMM

A high accuracy digital multimeter designed for those requiring true RMS ac waveform measurement. Includes 10MHz frequency counter, capacitance and temperature measurement (probe included). Relative function, backlit LCD, USB datalogging also in-built (lead included). Cat III 600V.

$74.95 NEW!

Q 1074A

New higher resolution LCR functions



$229 NEW!

Q 2112

Peak® LCR & Impedance Analyser

Identifies inductors, capacitors and resistors. Can also display the components parameters as a complex impedance, complex admittance or magnitude and phase of impedance. 2 year warranty. **Designed & made in the UK.**

Must have for electronic servicing.

$259 NEW!

Q 2115

Peak® USB Semiconductor Analyser

Much like our popular Q 2100 Peak analyser with added features including PC/USB interface which allows detailed curve tracing analysis of components, plus measure a range of part values like gain and leakage. 2 year warranty. **Designed & made in the UK.**

X 0111

$120 SAVE $20

Blast dirt, grease and grime away instantly.

No need for harsh solvents. 170 Watts of ultrasonic cleaning power - over twice the power of our X 0109 model. In-built heater helps to lift more dirt than ever before. Great for high use applications - labs, optical outlets, jewellers etc. 2500ml tank. 240V operation.

Thousands sold! A top quality, affordable iron for the enthusiast.

T 2416

$79 SAVE $20

Micron® 45W Digital Soldering Station

An excellent multi purpose soldering iron for service technicians, schools, engineers, R&D, production work etc. Japanese long life ceramic element. 150°-480°C. Suits lead free soldering. 0.8mm tip. **2 year warranty.**

Tough aluminium case

$42 SAVE 15%

X 0215

5W LED Aluminium Adjustable Torch

Super tough aluminium case! 300 Lumens output. Flashing mode and adjustable beam width. Requires 3xD batteries (S 4926 2pk $7.15). 335mm long.

'Contact Free' Digital Thermometer

With twin laser guided beam for ckn point accuracy. Lightweight, "point and shoot" temperature measurement. Provides accurate readings between -35 and 800°C from a distance. Ideal for measuring in dangerous places, or when equipment is operating. 12:1 resolution. 300ms response. 1% accuracy. Includes carry case.

Q 1284

$95 SAVE $40

Ideal for cutting solid core wires

T 2749

$49.95 NEW!

Tungsten Steel Side Cutters

Yes, they are pricey! But they are likely to be the last pair of side cutters you'll ever purchase. Made from incredibly tough heat treated tungsten steel. 130mm long.

One-Touch Battery Testing

Provides a quick and easy verification of battery condition for 12V sealed lead acid (SLA), wet cells, gel cell & AGM batteries. Applies a 20A test load and determines charge level. Q 1055 carry case to suit $6.50.

Q 3215

Suits 5Ah to 80Ah batteries

$33 SAVE 17%

High Power Blow Torches

Super hot 1350°C flame!

Handheld or self standing design for tasks such as heatshrinking, model making, silver soldering! Gas and air flow adjustments. Easily refilled with butane gas. T 2494 features a robust all aluminium design.

T 2492 Small

$32 SAVE 20%

T 2494 Large

$63 SAVE 20%

Add a can of gas for $7.50

12 In 1 Ratchet Driver Kit

Driver bits are stored inside the handle! Ideal for communications gear, phones, laptops. Includes: • Extension bar • #000, #00, #0 phillips • 1.5, 2 & 2.5mm flat blade • T4, T6, T7, T8, T10, T15 torx.

$16 SAVE 19%

T 2189A

Tuff & Nut

Super-Tough Equipment Carry Cases!

IP67 rated for the ultimate dust and water protection for your precious equipment. Ideal for storing test equipment, cameras, computers and sensors. Foam inner can be customised to suit your equipment. Foam lined lid for secure fit. Latches can be padlocked. T 5052-65 include shoulder strap.

Just like the brand names for far less!

Size	Part	Normally	Now...
365x266x165mm	T 5050	$98.50	$78
465x365x185mm	T 5052	$179	$140
515x435x199mm	T 5054	$269	$199
650x430x250mm	T 5065	$485	$379

20% OFF

*Dimensions are external

ALTRONICS
BUILD IT YOURSELF ELECTRONICS CENTRE

Our Build It Yourself Electronics Centres...

» **Balcatta WA:** 7/58 Erindale Rd » **Cannington WA:** 6/1326 Albany Hwy
» **Perth WA:** 174 Roe St » **Auburn NSW:** 15 Short St » **Springvale VIC:** 891 Princes Hwy

$249 SAVE $100

S 9406A

Peace of mind for the family!

Colour TFT Video Door Intercom

• A safe & easy way to monitor the front door • Ultra-sharp 7" colour screen • Records photos of visitors when you're not home • USB/SD photo, video & MP3 playback • Includes power supply, hookup cable, base station & camera unit • Remote door latching* • Expandable to 4 base stations (S 9407) & 2 cameras (S 9409). *When used with optional door strike S 5385 $44.95.

$99 NEW!

X 2320 10W

$139 NEW!

X 2321 20W

Brilliant Battery Powered Portable Work Lights

LED floodlamps coupled with a rechargeable battery offering up to 6 hours use away from mains power. Includes work stand, car charger & plugpack. Great for work sites & service vans.

X 2350

$54.95 NEW!

Great party light!

X 2290 36° X 2292 60°

$29.50 SAVE 10%

or 6up $25ea

Add atmosphere to your back yard!

This 10 Watt RGB floodlight can produce a huge array of colours and lighting effects. Easy IR remote control adjustments. Fully weatherproof IP65 rated. Fitted with 240V mains plug. 115W x 87H x 81Dmm.

8 Watt MR-16 Halogen Replacement LED Globes

Direct replacement for MR-16 halogen globes. The overall light output and colour rendering of these globes is sure to impress! For a $30 investment you could save up to $600 on your power bill per globe changed over its life time.

True 50W halogen equivalent with 80% lower power consumption.

High Brightness LED Globes

For exceeds the life of CFL bulbs. Fits standard fittings. Warm white, 7 Watts (equivalent to normal 40 Watt bulb).

X 2271 Edison Screw
X 2281 Bayonet

4 for $40 SAVE 20%

Handy DIY Kit Designs

K 3205

$59.50 NEW!

Shortform Case Kit For Hybrid Power Supply

Pre-cut case, meters and power switch for the O-40V, 5A hybrid power supply published in the April/May issues of Silicon Chip.

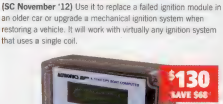
Great for D-I-Y & trades.

K 6043

$39 SAVE 20%

Take the 'kick' out of your power tools!

(SC July '12) This handy soft starter kit prevents your electric saw, router or other large mains-powered hand tool from kicking when you squeeze the trigger. Ensures a clean accurate cut every time. Max load 10A.



$42 SAVE 26%

K 4030

High Energy Ignition Kit

(SC November '12) Use it to replace a failed ignition module in an older car or upgrade a mechanical ignition system when restoring a vehicle. It will work with virtually any ignition system that uses a single coil.

$130 SAVE $68

K 1143

Huge saving!

GPS Boat Computer Kit

(SC Oct '10) Never get lost at sea again! Shows speed and heading - plus it will navigate you back home - or to that secret fishing spot! It even displays fuel consumption, along with a host of other vital information.

Fully up to date model with all circuit improvements made by Silicon Chip.

K 6032

$249 NEW!

1.5kW Induction Motor Speed Controller Kit

(SC April-May '13) This revolutionary design is suitable for motors up to 1.5kW (2HP) and can be used to control speed over a wide range. It will save big dollars with swimming pool pumps and will be great for running machinery at different speeds. Even better, it will control 3-phase motors as well! **Note:** This is a kit design for advanced constructors. Designed for connection to 240V mains devices.

Resellers

WESTERN AUSTRALIA		
Esperance	Esperance Comms.	(08) 9071 3344
Geraldton	ML Communications	(08) 9965 7555
VICTORIA		
Bairnsdale	Bairnsdale Electrics	(03) 5152 3201
Beaconsfield	Electronic Connections	(03) 9768 9420
Bendigo	Interact Us	(03) 5444 3000
Castlemaine	Top End Technology	(03) 5472 1700
Clayton	Rockby Electronics	(03) 9562 8559
Cranbourne	Bourne Electronics	(03) 5996 2755
Croydon	Truscott's Electronic World	(03) 9723 3860
Geelong	Music Workshop	(03) 5221 5844
Healesville	Amazon DVDs Healesville	(03) 5962 2763
Hoppers Crossing	Leading Edge	(03) 9931 0846
Leongatha	Gardner Electronics	(03) 5662 3891
Nunawading	Semtronics	(03) 9873 3595
Preston	Preston Electronics	(03) 9484 0191
Rosebud	AV2PC	(03) 5986 6711
San Remo	Shoreline Elec. Wholesale	(03) 5678 5361
Somerville	AV2PC	(03) 5978 0007
Wodonga	Exact Comp. & Home Ent.	(02) 6056 5746
TASMANIA		
Hobart	Active Electronics	(03) 6231 0111
Launceston	Active Electronics	(03) 6334 7333
QUEENSLAND		
Bowen Hills	Prime Electronics	(07) 3252 7466
Caloundra	LESC	1300 716 840
Clontarf	Access Electronics	(07) 4742 2590
Coorparoo	Delsound	(07) 3397 8155
Fortitude Valley	Design Data	(07) 3854 1588
Gold Coast	Prime Electronics	(07) 5531 2599
Hervey Bay	Ultra Music	(07) 4128 2037
Innisfail	Leading Edge Electronics	(07) 4061 6214
Loganholme	UC Technology Solutions	(07) 3806 5111
Longreach	Access Electronics	(07) 4658 0500
Rockhampton	Access Electronics	(07) 4922 1058
Toowoomba	Michael's Electronics	(07) 4632 9990
Townsville	SOLEX	(07) 4771 4211
NEW SOUTH WALES		
Brookvale	Brookvale Electrical Dist.	(02) 9938 4299
Cessnock	Leading Edge Electronics	(02) 4990 5971
Cobar	Cobar Electronics	(02) 6836 2962
Deniliquin	Wired Entertainment	(03) 5881 3555
Gloucester	Autolec Gloucester	(02) 6558 1600
Grafton	Downes Electronics	(02) 6642 1911
Griffith	Griffith Systems Plus	(02) 6964 5933
Gunnedah	Protronics	(02) 6742 2110
Lithgow	Leading Edge Electronics	(02) 6352 3333
Nth Richmond	Candle Power Tech.	(02) 4571 4699
Oak Flats	Oak Flats Electronics	(02) 4256 6120
Orange	Fordray Electronics	(02) 6362 9901
Penrith	Penrith Light and Sound	(02) 4733 3333
Port Macquarie	Fettel Comms.	(02) 6581 1341
Smithfield	Chantronics	(02) 9609 7218
Tamworth	Bourke Street Electronics	(02) 6766 4664
Taree	Noeledge Systems Pty Ltd	(02) 6551 3622
Wagga Wagga	Wagga Car Radio	(02) 6925 6111
Waterloo	Herkes Electrical Supplies	(02) 9319 3133
Wetherill Park	Techtron Electronics	(02) 9604 9710
Windang	Mad Electronics	(02) 4297 7373
Wollongong	Lightsounds Wollongong	(02) 4226 1177
Wyong	Coastal Caravan And RV	(02) 4353 1100
SOUTH AUSTRALIA		
Adelaide	Adtronics	(08) 8212 6212
Brighton	Force Electronics	(08) 8377 0512
Enfield	Adtronics	(08) 8349 6340
Findon	Force Electronics	(08) 8347 1188
Kadina	Idyll Hours Hobbies	(08) 8821 2662
Mount Barker	Home of 12 Volt	(08) 8391 3121
NORTHERN TERRITORY		
Darwin	Combined Comm. Solutions	(08) 8942 0644
NEW ZEALAND		
Christchurch - Riccarton	Global PC	+64 3 3434475
Christchurch - Shirley	Global PC	+64 3 3543333

Sale Ends July 31st 2014

Altronics Phone 1300 797 007 Fax 1300 789 777
Mail Orders: C/- P.O. Box 8350 Perth Business Centre, W.A. 6849

© Altronics 2014. E&OE. Prices stated herein are only valid for the current month or until stocks run out. All prices include GST and exclude freight and insurance. See latest catalogue for freight rates. All major credit cards accepted.

Please Note: Resellers have to pay the cost of freight and insurance and therefore the range of stocked products & prices charged by individual resellers may vary from our catalogue.

C0812

L-o-o-o-n-g gating times for the 12-Digit High-Resolution Counter

By JIM ROWE

This add-on PCB module enables higher resolution measurements with the 12-Digit Frequency/Period Counter described in the December 2012 & January 2013 issues of SILICON CHIP. It adds an additional decade divider for the external timebase input to allow measurements using a gating time of 10,000 seconds (nearly three hours) and includes front-panel LEDs for gating indication.

DURING OUR RECENT work in calibrating an ex-telecoms rubidium frequency standard (SILICON CHIP, April 2014 issue), it became apparent that it was possible to improve the 12-Digit High Resolution Counter to make it better for this type of very high resolution frequency measurement. This would involve a small module which could be built inside the counter's case. The end result provides three separate improvements, as outlined below.

One of the functions I wasn't able to provide on the original 12-digit counter was any indication of when the counter's gate is open and counting is under way. This doesn't matter much when you're making measurements at short gating times like 1 second or 10 seconds, because each new reading follows the last in relatively short order. But it becomes a drawback when you're using longer gating times for higher resolution frequency measurements.

For example, if you want to measure with a resolution of 1mHz (0.001Hz), each measurement involves a gating time of 1000 seconds and there's also a gap of 1000 seconds between measurements, because of the way the counter works. Without any indication of when the gate is actually open and counting is taking place, it's not possible to tell whether it's counting or 'waiting between counts'.

So one of the improvements provided by the new add-on module is to provide an indication of when the counter's gate is open and counting is under way. It does this with a bi-colour LED, which is red when the gate is open for odd counts and green when the gate is open for alternate even counts. Because it doesn't light at all during the gaps between counts, this makes it quite easy to tell at a glance what the counter's status is at any particular time.

But what if you're over the other side of the room, or perhaps in another room – so you can't be glancing over at the counter all the time? To solve this, the module includes a simple beeper circuit, which operates a piezo buzzer for a short time at the start of each new counting period. So all you need to do is keep an ear out for the beep, to let you know when a new count has begun. Then you can go over to the counter and record the previous count (which continues to be displayed during the new count).

The circuit of the add-on module has been arranged so that the beeper is only activated when the counter is set for gating times of 100s or more. For the shorter gating times, it's disabled.

The beeper circuit is also link-programmable with respect to the actual beep duration. There's a choice

of four different beep durations: 0.5 seconds, 2 seconds, 16 seconds or 128 seconds. So you can easily select the duration that's most suitable for your application.

The third improvement provided by the new module enables the counter to make *really* high resolution measurements. It's an additional synchronous decade divider for the counter's external timebase input, so that the maximum gating time/counting period can be extended to 10,000 seconds – allowing you to make frequency measurements with a resolution of 100μHz (100 microhertz or 10^{-4} Hz).

But there's a price to pay for making this type of measurement with the counter: each count will take 2 hours and 47 minutes, with a gap of the same duration between counts. So you'll need to be patient but at least the indicator LED and beeper will let you get on with other things!

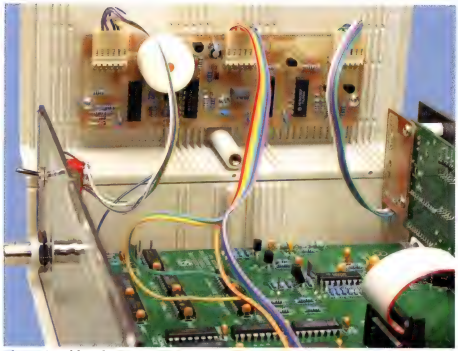
Note that the additional timebase divider can be switched out of circuit when it's not needed and another LED indicates when the additional divider is being used. This LED will also remind you to 'bump up' the decimal point in the counter's display, because the counter itself has no way of knowing that the additional divider is in use.

Circuit details

The full circuit for the new add-on module is shown in Fig.1. The circuitry for the 'gate open' indication is at the top, the 'beep at the start of each count' function is in the centre and the additional timebase divider circuitry is at the bottom.

The 'gate open' indication circuitry involves gate IC1b, flipflop IC2a and transistors Q1, Q2 & Q3. IC1b is used as an inverting buffer, which takes a 'GATE OPEN-bar' signal derived from pin 2 of IC18a on the counter's main PCB and inverts it to provide an active high 'GATE OPEN' signal with a positive-going leading edge. This leading edge is then used to toggle flipflop IC2a, which therefore changes state at the start of each new count.

The flipflop's two outputs (Q and Q-bar) are then used to control transistors Q2 & Q3, so only one of these is able to conduct at any time to allow current to flow through either LED1a or LED1b. This depends on whether the counter is performing an odd count or an even count, although these labels are purely arbitrary.



The main add-on logic module is mounted on the lid of the counter's case, while the smaller add-on LED board is attached to one end of the counter's display PCB. An extra switch is also mounted on the rear panel.

Whether either of the two LEDs is able to conduct current doesn't just depend on transistors Q2 & Q3, however; because neither LED can pass current unless transistor Q1 is also conducting. Q1 is only able to conduct current when it is provided with forward base current via the 22kΩ series resistor connected to pin 4 of IC1b.

So Q1 only conducts when the 'GATE OPEN' signal on pin 4 of IC1b is high (ie, during counting).

Hence LED1a lights only during odd counting periods and LED1b is on only during even counting periods. In the gaps between counting periods, both LEDs remain dark.

Gating beeper circuit

The beeper section involves gates IC1a, IC1c & IC1d, together with timer IC3 and transistor Q4 to switch the piezo buzzer on and off.

The input gating circuitry may look a little strange but it's really quite straightforward. IC1a is being used as another inverter, to derive a 'GATE OPEN-bar' signal from the signal at pin 4 of IC1b. This is then fed to pin 13 of IC1d, used here as a negative input logic AND gate.

We don't want the beeper to function when the counter is being used with the shorter gating periods, so the second input of IC1d (pin 12) is connected to IC1c's output pin (pin 10), while IC1c's inputs are connected to two pins of IC23 on the main counter PCB: pin 2, which carries the 100s gating signal (H = 100s gating) and pin 6 which carries the 1000s gating signal (H = 1000s gating).

Since IC1c a NOR gate, this means that its pin 10 output will only switch low when the counter is set for either 100s or 1000s gating. Accordingly, pin 12 of IC1d will only be taken low for these gating times also, and will be kept high for the shorter gating times. So even when pin 13 of IC1d drops low during GATE OPEN' periods, IC1d's pin 11 output will not be able to switch high unless the counter is set for either 100s or 1000s gating.

The output from pin 11 of IC1d is coupled to the MRST input (pin 6) of timer chip IC3 via a differentiator circuit using a 470nF capacitor and 10kΩ resistor. This is done so that IC3 only receives a short triggering pulse, derived from the leading edge of the gated positive-going signal from IC1d. I'll explain the reason for this shortly.

IC3 is a 4541B programmable digital CMOS counter/timer, used here to time the duration of our 'start of a new count' beeper. It's triggered via MRST input pin 6, while its output at pin 8 is used to control the piezo buzzer via transistor Q4. The duration of the output pulse (and therefore the length of the beep) is determined by

Parts List

1 PCB, code 04106141, 169 x 45mm (cut into two boards, 137 x 45mm & 30.5 x 45mm)
3 6-pin PCB-mount right-angle polarised locking headers, 0.1-inch spacing
3 6-pin polarised locking plug sockets, 0.1-inch spacing
2 2-pin SIL headers (or 1 x 4-pin DIL header) for LK1 & LK2)
2 2-pin jumper shunts
1 piezo buzzer, 24mm diameter, PCB mounting
1 DPDT panel-mount mini toggle switch
1 1m-length of 6-conductor rainbow ribbon cable
3 6G x 6mm self-tapping screws
2 M3 x 9mm machine screws
2 M3 flat washers

Semiconductors

1 4001B quad CMOS NOR gate (IC1)
1 4013B dual D-type flipflop (IC2)
1 4541B programmable CMOS timer (IC3)
1 4017B Johnson decade counter/divider (IC4)
2 PN100 NPN transistors (Q1,Q4)
2 PN200 PNP transistors (Q2,Q3)
1 5mm 3-pin common-cathode red/green bicolour LED (LED1) (Altronics Z0885)
1 3mm blue LED, waterclear (LED2)
3 1N4148 silicon diodes (D1-D3)

Capacitors

1 10µF 16V RB electrolytic
1 470nF MKT or MMC
6 100nF MMC (multilayer monolithic ceramic)

Resistors (0.25W 1%)

1 33kΩ	1 2.2kΩ
4 22kΩ	2 1kΩ
2 15kΩ	1 470Ω
6 10kΩ	1 100Ω

the timing components connected to pins 1, 2 & 3, which set the frequency of the 4541B's internal clock oscillator and also by links LK1 and LK2 which program the 4541B in terms of its timing count setting. As you can see from the small table at centre left of Fig.1, the link combinations provide a choice of four beep durations: from half a second up to 128 seconds.

But why did we have to provide a short triggering pulse for IC3 – why couldn't we simply use the logic output signal from IC1d directly? That's because IC3 only provides its 'end of timing count' output pulse from pin 8 if the input triggering pulse supplied to pin 6 has ended. And in this circuit, the output signal from IC1d can of course stay at the high logic level for as long as 100s or 1000s (or even 10,000s), which would prevent IC3 from ever activating the beeper.

So by using the simple differentiator shown, we derive a relatively short trigger pulse from the rising edge of the output signal from IC1d, ensuring that the triggering signal at pin 6 of IC3 has dropped back to zero in no more than about 100ms. This allows correct beeper operation, even with a beep duration of only 0.5 seconds.

By the way, diode D3 is provided simply to ensure that any negative pulse appearing at input pin 6 of IC3 when the output of IC1d does drop back to zero (when the counter's gate finally closes) is limited to an amplitude of -0.6V.

Additional divider stage

Now let's look at the circuitry at the bottom of Fig.1, which provides the additional 'divide-by-10' function to extend the counting duration when using an external timebase, eg, the 1Hz pulses from a GPS receiver or a rubidium time and frequency standard.

This uses a 4017B Johnson-type synchronous CMOS decade counter (IC4). Its CP0 input (pin 14) is connected directly to CON3 at the rear of the main counter PCB, which is disconnected from the original external timebase input by removing the 1kΩ series resistor just to the front of CON3. Diodes D1 and D2, together with the 100Ω and 22kΩ resistors, are used to protect the input of IC4 from possible over-voltage damage.

This additional timebase divider is always fed with the external timebase signal from CON3. However, whether or not its output is fed to the external timebase input of the counter is controlled by added switch S1, which is fitted to the counter's rear panel. This is a double-pole switch, with its 'a' section used to select either the raw external timebase signal from CON3 or alternatively, the pin 12 output of IC4.

S1a's common terminal is connected back to the external timebase input of the counter via a 1kΩ series resistor, which replaces the one that's removed to tap into the signal from CON3.

S1b is simply used to switch LED2 in or out of circuit, so that this LED only glows when S1a has been set to make use of the additional timebase divider.

One last point: the 100nF capacitor and 10kΩ resistor connected to pin 15 of IC4 are simply there to deliver a short reset pulse to this IC when power is first applied to the counter, so that IC4 starts off 'on the right foot'.

Construction

As shown in Fig.2 and the photos, virtually all the components used in the add-on module are fitted onto two small PCBs, which are cut apart from a single board measuring 169 x 45mm and coded 04106141. The larger PCB (coded 04106141a) carries most of the components and circuitry, and mounts up inside the righthand end of the counter's lid.

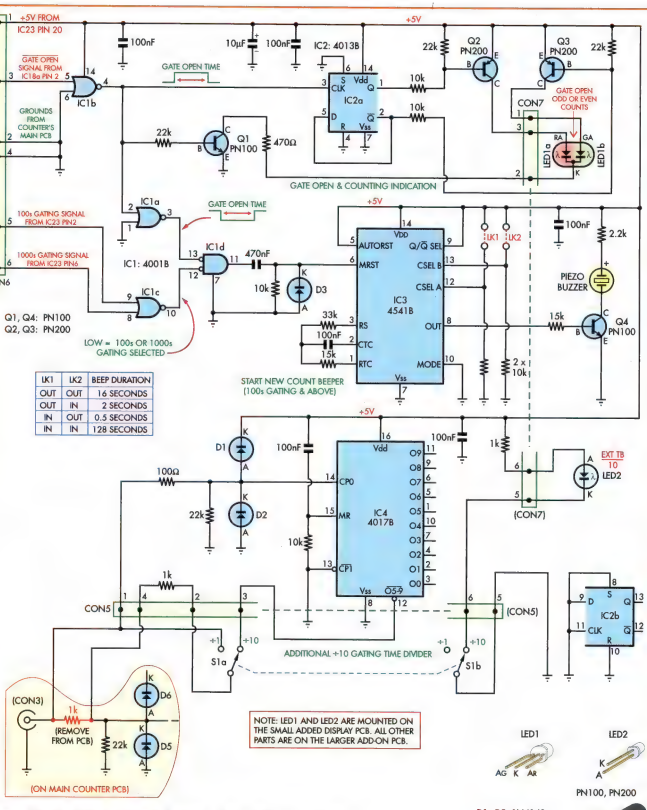
The smaller PCB (coded 04106141b) carries only the two extra LEDs and is mounted at the righthand end of the counter's display PCB, behind the front panel and with the extra LEDs just protruding through two additional holes in the panel.

Three ribbon cables are used to make the connections. These go between the two add-on PCBs, between the larger add-on PCB and the main counter PCB, and to added switch S1 and the external timebase input circuitry (CON3). This should all be fairly clear from the overlay diagram of Fig.2 and also the internal photos.

Cut the two boards apart and smooth their cut edges with a small file before you add any of the components. You can then begin the assembly of the larger board by installing the two wire links, followed by the resistors, diodes, capacitors, transistors and ICs.

The three 6-pin 90° header plugs and the two 2-pin SIL headers for LK1 and LK2 can then go in. The piezo buzzer can be left until last, as it's relatively large and makes it hard to access some of the other components once it's in place.

Next, you can fit the two LEDs to the smaller PCB, both with their 'flat' sides (cathodes) downwards as shown in Fig.2. Leave their leads about 14mm long above the top surface of the PCB, as this will be about the right length for the LEDs to protrude slightly through



LK1	LK2	BEEP DURATION
OUT	OUT	16 SECONDS
OUT	IN	2 SECONDS
IN	OUT	0.5 SECONDS
IN	IN	128 SECONDS

ADD-ON MODULE FOR HI-RES COUNTER

Fig.1: the add-on module is based on four CMOS ICs (IC1-IC4). The 'gate open' indication circuitry is at the top, the 'beep at the start of each count' circuit is in the centre and the added timebase divider circuitry is at the bottom.

the front panel when the board is mounted in position.

Once both PCBs have been fully assembled, the larger one can be fitted inside the upper half of the counter's case, at the righthand end. Note that it's mounted upside-down, with the copper side towards the case lid and the component side facing inwards.

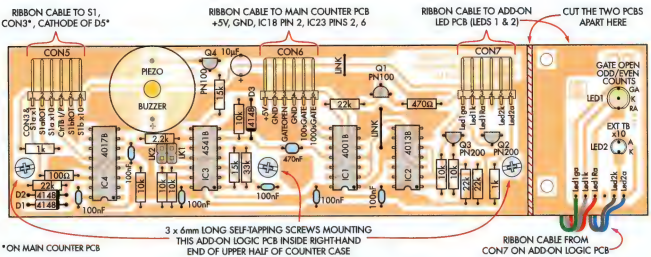


Fig.2: cut the PCB into two sections as indicated, before installing the parts on the two modules. Make sure that all polarised parts are correctly orientated and be careful not to get the ICs mixed up. The photo at right shows the completed add-on logic module mounted in place on the case lid.

The PCB is held in place using three small 6mm long self-tapping screws which mate with three of the small standoffs moulded inside the case lid at that end.

After that, you need to drill two additional holes in the counter's front panel (to allow the two extra LEDs to protrude and be visible) and also a single additional hole in the rear panel to accept toggle switch S1.

Fig.5 shows the size and location of these two additional holes in the front panel. Note that these line up horizontally with the uppermost and lowest of the three existing LED holes in the panel just to the right of the main display window, but are only 10mm in from the righthand end of the panel.

The single additional hole in the rear panel should have a diameter of 6.5mm to allow S1 to be fitted but its exact location is not critical.

This should be located directly above CON3, about 55mm up from the bottom of the rear panel. This allows S1 to be activated quite easily by reaching over the case top.

The next step is to make up the three interconnecting ribbon cables. One of these (the one to connect from the centre connector to various points on the main counter PCB) should be about 300mm long, while the other two can be around 230mm long.

One of the two shorter cables (the one used to connect to the small LED display PCB) needs only five conductors rather than six.

To assemble each cable, bare all of their conductors for about 4mm at each end. Then you need to crimp and solder each conductor (at one end) to one of the pins of a 6-way polarised and locking header socket. That done, you can cut the pins from their carrier strip and push each one into the slots of the plastic socket moulding. Make sure that you push each clip fully home, ie, until its small barb clicks into the slot near the end. If you don't do this, the clips won't remain in position.

Make sure also that with the 5-wire shorter cable, you push the five clips into slots 1, 2, 3, 5 & 6 of the header socket. **Leave slot 4 empty, because the corresponding pin of CON7 (the connector with which this cable socket mates) isn't used.**

Once the header sockets have been attached to one end of each cable, you're then ready to connect the free ends of each cable to the designated points on either the small add-on display PCB, the counter's main PCB or the added toggle switch S1, on the rear panel.

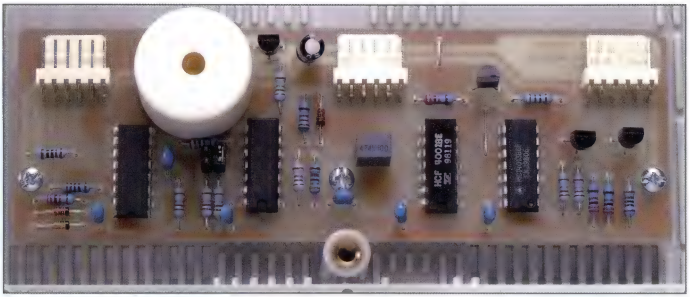
For example, the conductors of the short 5-way cable are connected to their matching holes along the bottom of the LED display PCB (04106141b), as shown at bottom right in Fig.2. Once all five have been soldered to their

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
470nF	0.47µF	470n	474
100nF	0.1µF	100n	104

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	4	22kΩ	red red orange brown	red red black red brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	6	10kΩ	brown black orange brown	brown black black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown



pads on the rear of the add-on LED PCB, this board can be fitted into the counter case.

Mounting the LED board

As you can see from Fig.3 and one of the inside photos, the added LED display PCB is mounted just behind the counter's existing main display PCB, at its righthand end (as viewed from the front of the counter). This is done by removing the two existing M3 x 6mm screws attaching the main display PCB to the Nylon spacers at that end, and then replacing them with two M3 x 9mm screws and M3 flat washers.

Each of these screws pass through a mounting hole of the add-on LED PCB (from the copper side), then through an M3 flat washer (acting as a thin spacer) before passing through the holes in the main display PCB and then into the Nylon spacers as before. When both screws are tightened, both boards will then be mounted securely behind the front panel.

Once the other shorter ribbon cable has been fitted with its 6-way header socket and clips, you can then solder the free ends of two of its conductors to the main counter PCB, just behind CON3 at the right rear and to the pads at each end of the position where the 1kΩ resistor was removed (see photo).

Basically, the conductor coming from pin 4 of CON5 (on the add-on logic PCB) connects to the pad on the left, while the conductor from pin 1 of CON5 connects to the pad on the right. **The latter also connects to the upper left lug of switch S1, although you may wish to make this second connection using another short length of hookup wire.**

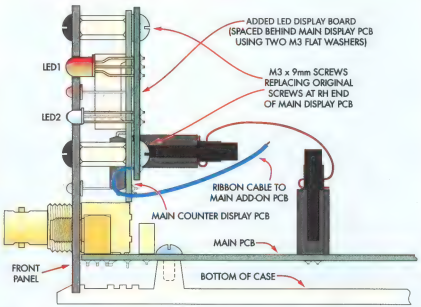


Fig.3: this cross-section diagram shows how the add-on LED display PCB is attached to the righthand end of the original display PCB (as viewed from the front) using two M3 flat washers plus two M3 x 9mm machine screws into the original Nylon spacers.

The other four conductors of this ribbon cable connect to the other lugs of S1. The one from CON5 pin 2 goes to the centre lefthand lug, while the one from CON5 pin 3 goes to the lowest lug on the lefthand side.

Similarly, the one from CON5 pin 6 goes to the lowest lug on the righthand side of S1, while the one from CON5 pin 5 goes to the centre-right lug of switch S1 (the common terminal).

All that remains after the two shorter ribbon cables have been fitted is to do the same with the longest of the three cables. This is the one used to make the connections between CON6 of the add-on logic PCB to various points on the counter's main PCB. All of these points are pins on two of the ICs and it's quite easy to solder each lead to its corresponding pin using a fine-tipped soldering iron.

Here's how these conductors are wired. First, the wire from CON6 pin 1

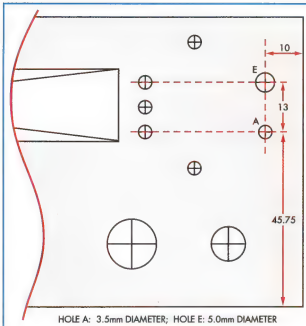


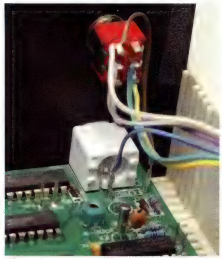
Fig.4: follow this diagram to mark out and drill the two additional holes in the front panel.

goes to pin 20 of IC23, on the lefthand rear side of the main PCB. The wire from CON6 pin 2 then goes to pin 1 of the same IC, while the wires from CON6 pins 5 & 6 go to pins 6 & 2 of IC23, respectively.

The remaining two conductors are taken to two pins of IC18. In this case, the wire from CON6 pin 3 goes to pin 2 of IC18, while the one from CON6 pin 4 goes to pin 7 of IC18.

All that remains is to fit whatever combination of jumper shunts you wish to LK1 and LK2 (just to the left of IC3 on the add-on logic PCB), to program it for the beep duration you want, and then plug each of the three interconnecting ribbon cables into their correct pin headers (ie, into CON5, CON6 & CON7). That done, you should be able to refit the case lid to the counter and apply power to get it all working again.

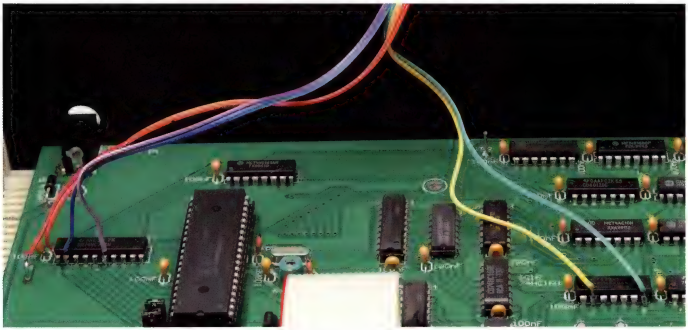
Don't be surprised when the counter emits a beep as soon as power is turned back on. This doesn't indicate any sort of problem; it's just a quirk of the 4541B timer IC, which produces an output pulse as soon as power is applied.



This photo shows the wiring to DPDT toggle switch S1, to CON3 and to the main PCB where the 1kΩ resistor was removed (ie, just behind CON3).

Final comments

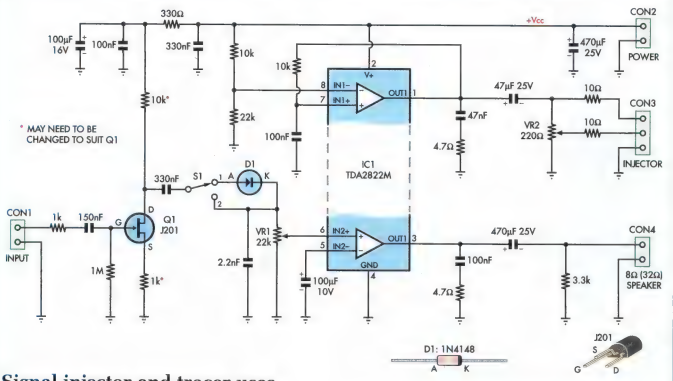
This circuit is a worthwhile addition to the 12-Digit High-Resolution Counter, especially if you will be making high-resolution measurements. Admittedly, such measurements will be very time-consuming compared to a counter which has interpolation technology instead of the long-term averaging system we used in the December 2012/January 2013 design. SC



The connections from the add-on logic module to the main counter PCB, the add-on LED PCB and to other components are run using ribbon cable.

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.



Signal injector and tracer uses TDA2822M dual power amplifier

The TDA2822 dual power amplifier has other applications besides being used as an audio amplifier. In this circuit, one half is used as a free-running audio oscillator to be used as a signal injector for trouble-shooting audio circuits while the other half is used as a signal tracer.

In use, the signal injector is fed into the input of the equipment being investigated while the signal tracer is used to check how the signal amplitude changes as it progresses through the various stages.

Let's have a look at the audio oscillator section first. The inverting input, pin 8, is biased by a voltage divider consisting of 10kΩ and 22kΩ resistors. The non-inverting input, pin 7, has a 100nF capacitor connected to the 0V line and this is alternately charged and discharged from the output at pin 1 via the 10kΩ resistor.

This results in a triangle waveform at pin 7 and a square wave at pin 1, running at about 1kHz. This is coupled to level potentiometer VR2 via a 47µF capacitor and directly to the output connector CON3 via a 10Ω resistor. Hence there are fixed and variable outputs available at CON3.

The fixed output can drive an 8-ohm or higher impedance loudspeaker or headphones while the variable output can be used for the above-mentioned signal injector function.

The second power amplifier in the TDA2822M (IC1b) is used for the signal tracer function. It is preceded by a J201 junction FET which is used as a high-impedance gain stage. Its drain output is coupled via a 330nF capacitor to switch S1.

For tracing RF signals, this can be switched to select diode D1, which, in conjunction with the 2.2nF capacitor will function as an AM signal demodulator. The recovered audio modulation is then fed via potentiometer VR1 to IC1a.

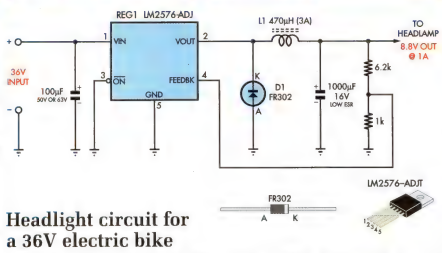
Alternatively, switch S1 can be moved to position 2, bypassing diode D1, to couple the audio signal directly to VR1.

Note that the circuit is sensitive enough to be fed with typical dynamic microphones as well.

IC1b has a typical fixed gain of 39dB (ie, 90 times) and drives an external loudspeaker or headphones of between 8-32Ω. Potentiometer VR1 should be adjusted to provide a comfortable volume.

Petre Petrov,
Sofia, Bulgaria. ($50)

Issues Getting Dog-Eared? *Keep your copies safe with our handy binders*
Order online from www.siliconchip.com.au or fill in and mail the handy order form in this issue or ring (02) 9939 3295 and quote your credit card number.



Headlight circuit for a 36V electric bike

There are now many very-high brightness LED headlamps on the market intended for pushbikes. Most are based around an 8.4V battery pack with either two lithium-ion cells in series or two sets of two cells in parallel.

However, the motors on most electric bikes are powered by a 36V battery. This switchmode supply efficiently steps down the 36V bike battery voltage to power an 8.4V LED headlamp.

The circuit uses a simple switcher, the LM2576-ADJ. This effectively provides a buck (step-down) regulator using only a few components. Power is applied to the load via an internal switching transistor in the regulator and through the 470µH inductor. When the regulator's internal switching transistor turns off, L1's magnetic field begins to collapse and as it decays, current continues to flow through the now conducting diode (D1). Then, power is reapplied to recharge the inductor's magnetic field and the process repeats.

The 1000µF output capacitor reduces supply ripple, while the 100µF capacitor at the input is for regulator stability. A voltage divider comprising a 6.2kΩ and 1kΩ resistor reduce the output voltage and applies this to the feedback input. The output voltage is maintained at about 8.8V with the feedback input at a nominal 1.23V.

More information can be found in the LM2576 data sheet (www.ti.com/lit/ds/symlink/lm2576.pdf) and switchmode design software is available at http://www.ti.com/tool/powerstage-designer

John Clarke,
Silicon Chip.

RS232 input for non-standard signals

While it serves its intended purpose of interfacing legacy equipment, the USB/RS232 interface circuit in the April 2014 issue of Silicon Chip does not handle TTL signals (0.8V low, 2.5V high) very well. It also does not have the specified input impedance of 3-8kΩ ohms for inputs of 3-15V, which is 2.5kΩ for an input of 10V.

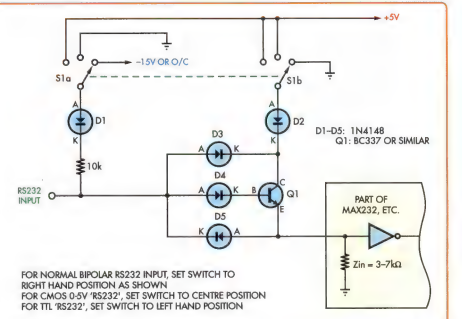
This alternative circuit has three settings:

(1) normal RS232: the output of the circuit is about 1.2V less than the input for positive voltages and -0.6V less than the input for negative voltages, with the input impedance approximately equal to the input impedance of the following MAX232 input pin (about 5kΩ).

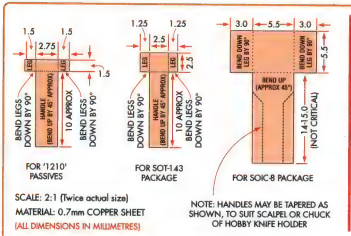
(2) CMOS: the input impedance of the circuit is increased by a factor of at least 50 for inputs in the range 0-5V, allowing CMOS to be interfaced. For outputs larger than 5V, the input impedance is the correct value, as the output current is supplied by the input current instead of the +5V supply.

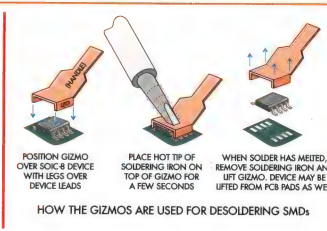
(3) TTL: the 10kΩ pull-up resistor increases the output voltage range of the TTL from 0.8-2.5V to 0.8-4.4V. This setting will not work with most CMOS circuitry.

If using multiple input lines, the circuit can be replicated using only the one double-pole 3-position switch.



Robert H. Bennett,
Auckland, NZ. ($40)





HOW THE GIZMOS ARE USED FOR DESOLDERING SMDs

Simple DIY gizmos for SMD desoldering

While surface-mount components may present challenges to solder, it can be far more difficult to desolder and remove them. Of course, such tasks are made straightforward if you have a professional soldering and rework station of the type that has both a soldering iron and a desoldering tool. The latter often has a hot-air blower system, plus a selection of multi-legged desoldering tips.

However, many hobbyists do not have one of these rework stations since they seldom need to remove and replace SMDs. For these readers, I have devised a set of desoldering attachments (gizmos) for a standard soldering iron tip, so that it can be used to desolder SMDs.

They're in the shape of a 'T' cut from small pieces of 0.7mm thick copper sheet and then bent up carefully using a small pair of pliers and/or a small vise so that they form an inverted-U shape with a 'handle' attached to one end. The handle is then used to position them above the device you want to desolder, with the 'legs' above the device leads (or ends of passive components).

Then when you apply the tip of your heated iron to the 'flat' on the top of the inverted U, its copper legs conduct the heat down to the component leads – heating all solder joints at the same time. After a few seconds you can then remove the iron tip and lift the gizmo clear.

You can then grab the device itself with tweezers and lift it from the PCB – although the gizmo often brings the device away with it, attached via capillary action in the still-molten solder. If the latter happens, you can usually nudge it away from the gizmo using your tweezers.

With the first couple of desoldering gizmos I made up, the handle section was made fairly short – just long enough to be locked between the jaws of a small scalpel. However, with the later and larger gizmos, I made the handle section somewhat longer and tapered it down on the outer end, so it would slip inside the chuck of a small hobby knife holder.

Either way, the scalpel or hobby knife holder becomes a convenient extension handle for the gizmo. This makes it possible for you to hold the gizmo in position with one hand, while you're holding the soldering iron with the other hand.

The dimensions of the gizmos are shown in the accompanying diagrams. The first is one to desolder 1206-size passive components (eg, resistors and capacitors), while the second one is a little larger for desoldering SOT-143 4-lead transistor packages. The third one is larger again, for desoldering 8-lead SOIC devices.

The second diagram shows how the gizmos are actually used, with the SOIC-8 gizmo shown as the example.

You can buy a small rectangle of 0.7mm copper sheet from hobby stores for just a few dollars.

Jim Rowe,
Silicon Chip.

MAY THE BEST contribution WIN!

As you can see, we pay $$$ for contributions to Circuit Notebook. Each month the BEST contribution *(at the sole discretion of the editor)* receives a **$150 gift voucher from Hare&Forbes Machineryhouse.** That's yours to spend at Hare&Forbes Machineryhouse as you see fit - buy some tools you've always wanted, or put it towards that big purchase you've never been able to afford!

$150 GIFT VOUCHER

HARE&FORBES MACHINERYHOUSE
100% Australian owned Established 1930
"Setting the standard in quality & value"
www.machineryhouse.com.au

Contribute NOW and WIN!
Email your contribution now to:
editor@siliconchip.com.au
or post to PO Box 139, Collaroy NSW

SILICON CHIP ONLINESHOP .com.au/shop

Looking for a specialised component to build that latest and greatest *SILICON CHIP* project? Maybe it's the PCB you're after. Or a pre-programmed micro. Or some other hard-to-get "bit". The chances are they are available direct from the *SILICON CHIP* ONLINESHOP. As a service to readers, *SILICON CHIP* has established the ONLINESHOP. No, we're not going into opposition with your normal suppliers – this is a direct response to requests from readers who have found difficulty in obtaining specialised parts such as PCBs & micros.

- PCBs are normally IN STOCK and ready for despatch when that month's magazine goes on sale (you don't have to wait for them to be made!).
- Even if stock runs out (eg, for high demand), in most cases there will be no longer than a two-week wait.
- One low p&p charge: $10 per order, regardless of how many boards or micros you order! (**Australia only**; overseas clients – email us for a postage quote).
- Our PCBs are beautifully made, very high quality fibreglass boards with pre-tinned tracks, silk screen overlays and where applicable, solder masks.
- Best of all, those boards with fancy cut-outs or edges are already cut out to the *SILICON CHIP* specifications – no messy blade work required!

HERE'S HOW TO ORDER:

VISA MasterCard PayPal

✔ **Via the INTERNET** (24 hours, 7 days)
Log on to our secure website: siliconchip.com.au, click on "SHOP" and follow the links.

✔ **Via EMAIL** (24 hours, 7 days)
email silicon@siliconchip.com.au – Clearly tell us what you want and include your contact and credit card details

✔ **Via FAX** (24 hours, 7 days)
(02) 9939 2648 (INT: 612 9939 2648). Clearly tell us what you want and include your contact and credit card details

✔ **Via MAIL** (24 hours, 7 days)
PO Box 139, Collaroy NSW 2097. Clearly tell us what you want and include your contact and credit card details

✔ **Via PHONE** (9am-5pm, Mon-Fri)
Call (02) 9939 3295 (INT 612 9939 3295) – have your order ready, including contact and credit card details!

YES! You can also order or renew your *SILICON CHIP* subscription via any of these methods as well!

PRE-PROGRAMMED MICROS Price for any of these micros is just $15.00 each + $10 p&p *per order#*

As a service to readers, *SILICON CHIP ONLINESHOP* stocks microcontrollers and microprocessors *used in new projects* (from 2012 on) and some selected older projects – pre-programmed and ready to fly!

PIC12F675-I/P	UHF Remote Switch (Jan09), Ultrasonic Cleaner (Aug10), Ultrasonic Anti-fouling (Sep10), Cricket/Frog (Jun12) Do Not Disturb (May13) IR-to-UHF Converter (Jul13), UHF-to-IR Converter (Jul13) PC Birdes "2 chips – $15 pair" (Aug13)
PIC16F1507-I/P	Wideband Oxygen Sensor (Jun-Jul12)
PIC16F88-E/P	Hi Energy Ignition (Nov/Dec12), Speedo Corrector (Sept13), Auto Headlight Controller (Oct13) 10A 230V Motor Speed Controller (Feb14)
PIC16F88-I/P	Projector Speed (Apr11), Vox (Jun11), Ultrasonic Water Tank Level (Sep11), Quizzical (Oct11) Ultra-LD Preamp (Nov11), 10-Channel Remote Control Receiver (Jun13), Revised 10-Channel Remote Control Receiver (Jul13), Nicad/NiMH Burp Charger (Mar14)
PIC16LF88-I/P	Garbage Reminder (Jan13), Bellbird (Dec13)
PIC16LF88-I/SO	LED Ladybird (Apr13)
PIC16F877A-I/P	6-Digit GPS Clock (May-Jun09), Lab Digital Pot (Jul10) Semtest (Feb-May12)
PIC18F2550-I/SP	Batt Capacity Meter (Jun09), Intelligent Fan Controller (Jul10)
PIC18F45K80	USB Power Monitor (Dec12)
PIC18F4550-I/P	GPS Car Computer (Jun10), GPS Boat Computer (Oct10)
PIC18F14K50	USB MIDIMate (Oct11)

Some micros from copyrighted and/or contributed projects may not be available.

PIC18F27J53-I/SP	USB Data Logger (Dec10-Feb11)
PIC18LF14K22	Digital Spirit Level (Aug11), G-Force Meter (Nov11)
PIC18F1320-I/SO	Intelligent Dimmer (Apr09)
PIC32MX795F512H-80I/PT	Maximite (Mar11), miniMaximite (Nov11), Colour Maximite (Sept/Oct12), Touchscreen Audio Recorder (Jun/Jul14)
PIC32MX250F128B-50I/SP	Micromite (May14) – *also includes* ***FREE*** *47µF tantalum capacitor*
PIC32MX250F128B-I/SP	GPS Tracker (Nov13) Micromite ASCII Video Terminal (Jul14)
PIC32MX470F512H-I/PT	Stereo Audio Delay/DSP (Nov13), Stereo Echo/Reverb (Feb 14)
dsPIC33FJ128GP802-I/SP	Digital Audio Signal Generator (Mar-May10), Digital Lighting Controller (Oct-Dec10), SportSync (May11), Digital Audio Delay (Dec11) Level (Sep11) Quizzical (Oct11), Ultra-LD Preamp (Nov11), LED Musicolor (Nov12)
dsPIC33FJ64MC802-E/P	Induction Motor Speed Controller (revised) (Aug13)
dsPIC33FJ128GP306-I/PT	CLASSIC DAC (Feb-May 13)
ATTiny861	VVA Thermometer/Thermostat (Mar10), Rudder Position Indicator (Jul11)
ATTiny2313	Remote-Controlled Timer (Aug10)
ATMega48-20AU	RGB LED Strip Driver (May14)
ATMega48	Stereo DAC (Sep-Nov09)

When ordering, be sure to nominate BOTH the micro required AND the project for which it must be programmed.

SPECIALISED COMPONENTS, SHORT-FORM KITS, ETC P&P – $10 Per order#

MAINS FAN SPEED CONTROLLER - AOT11N60L 600V Mosfet *(May14)* **$5.00**

RGB LED STRIP DRIVER - all SMD parts and 8SO150N03 Mosfets, does not include micro (see micro parts listed as "optional" *(May14)* **$20.00**

HYBRID BENCH SUPPLY- all SMD parts, 3 x BCM856DS & L2/L3 *(May 14)* **$45.00**

USB/RS232C ADAPTOR MCP2200 USB/Serial converter IC *(Apr14)* **$7.50**

NICAD/NIMH BURP CHARGER 1 SPD15P10 P-channel logic Mosfet & 1 IPP030N06L3 N-channel logic Mosfet *(Mar14)* **$7.50**

10A 230V AC MOTOR SPEED CONTROLLER 40A IGBT, 30A Fast Recovery Diode, IR2125 Driver and NTC Thermistor *(Feb14)* **$45.00**

STEREO AUDIO DELAY WM8731 DAC IC and SMD capacitors. *(Nov13)* **$20.00**

GPS Tracker MCP1630 SMD regulator IC and 15µH inductor *(Nov13)* **$5.00**

SMD parts for SiDRADIO *(Oct13)* **$20.00**

RF Probe All SMD parts *(Aug13)* **$5.00**
Same as LF-UP Upconverter parts but includes 5V relay and BF998 dual-gate Mosfet.

LF-HF Up-converter Omron G5V-1 5V SPDT 5V relay *(Jun13)* **$2.00**

"LUMP IN COAX" MINI MIXER SMD parts kit: *(Jun13)* **$20.00**
Includes: 2 x OPA4348AID, 1 x BD2057CSN, 2 x DMP2215L, 1 x BAT54S, 1 x 0.22kΩ shunt

LF-HF UP-CONVERTER SMD parts kit: *(Jun13)* **$15.00**
Includes: FXO-HC536R-125 and SA602AD and all SMD passive components

CLASSiC DAC Semi kit (Feb-May13) **$45.00**
Includes three hard-to-get SMD ICs: CS8416-CZZ, CS4398-CZZ and PLL1708DBQ plus an accurate 27MHz crystal and ten 3mm blue LEDs with diffused lenses

ISL9V5036P3 IGBT As used in high energy ignition *(Nov/Dec12)* **$10.00**
and Jacob's Ladder *(Feb13)*

2.5GHz Frequency Counter *(Dec12/Jan13)*
LED Kit: 3 x 4-digit blue LED displays **$15.00**
MMC & Choke Kit: ERA-2SM+ Wideband MMC and ADCH-80+ Wideband Choke **$15.00**

ZXCT1009 Current Shunt Monitor IC *(Oct12)* **$5.00**
As used in DCC Reverse Loop Controller/Block Switch (Pack of 2)

G-FORCE METER/ACCELEROMETER Short form kit (Aug11/Nov11) ~~$44.50~~ **$40.00**
(contains PCB (04108111), programmed PIC micro, MMA8451Q accelerometer chip and 4 Mosfets)

DIGITAL SPIRIT LEVEL Short form kit (Aug11/Nov11) ~~$44.50~~ **$40.00**
(contains PCB (04108111), programmed PIC micro, MMA8451Q accelerometer chip and 4 Mosfets)

IPP230N06L3 N-Channel logic level Mosfets **$7.50**
As used in a variety of SILICON CHIP Projects (Pack of 2)

JST CONNECTOR LEAD 3-WAY *(Jan12)* **$4.50**

JST CONNECTOR LEAD 2-WAY *(Jan12)* **$3.45**

RADIO & HOBBIES ON DVD-ROM (Needs PC & reader to play!) *n/a* **$62.00**

* All items subject to availability. Prices valid for month of magazine issue only. All prices in Australian dollars and included GST where applicable.

 # P&P prices are within Australia. O'seas? Please email for a quote

LOOKING FOR TECHNICAL BOOKS? YOU'LL FIND THE COMPLETE LISTING OF ALL BOOKS AVAILABLE IN THE SILICON CHIP ONLINE BOOKSTORE – ON THE "BOOKS & DVDs" PAGES OF OUR WEBSITE

PRINTED CIRCUIT BOARDS

NOTE: These listings are for the PCB only – *not a full kit.* If you want a kit, contact the kit suppliers advertising in this issue. Prices in RED are new lower prices, our cost is less so we pass the savings on to you. Buy now while stocks last!

PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
CHAMP: SINGLE CHIP AUDIO AMPLIFIER	FEB 1994	01102941	$5.00
PRECHAMP: 2-TRANSISTOR PREAMPLIER	JUL 1994	01107941	$5.00
HEAT CONTROLLER	JULY 1998	10307981	$10.00
MICROMITTER FM STEREO TRANSMITTER	DEC 2002	06112021	$30.00
SMART SLAVE FLASH TRIGGER	JUL 2003	13107031	$10.00
12AX7 VALVE AUDIO PREAMPLIFIER	NOV 2003	01111031	$25.00
POOR MAN'S METAL LOCATOR	MAY 2004	04105041	$10.00
BALANCED MICROPHONE PREAMP	AUG 2004	01108041	$25.00
POCKET TENS UNIT	JAN 2006	11101061	$25.00
STUDIO SERIES RC MODULE	APRIL 2006	01104061	$25.00
ULTRASONIC EAVESDROPPER	AUG 2006	01208061	$25.00
RIAA PREAMPLIFIER	AUG 2006	01108061	$25.00
KNOCK DETECTOR	JUNE 2007	05106071	$25.00
SPEAKER PROTECTION AND MUTING MODULE	JULY 2007	01207071	$20.00
LED/LAMP FLASHER	SEP 2008	11009081	$10.00
12V SPEED CONTROLLER/DIMMER (Use Hot Wire Cutter [Dec 2010] [18112101])			
USB-SENSING MAINS POWER SWITCH	JAN 2009	10101091	$45.00
DIGITAL AUDIO MILLIVOLTMETER	MAR 2009	04103091	$35.00
INTELLIGENT REMOTE-CONTROLLED DIMMER	APR 2009	10104091	$10.00
INPUT ATTENUATOR FOR DIG. AUDIO MVOLTMETER	MAY 2009	04205091	$10.00
6-DIGIT GPS CLOCK	MAY 2009	04105091	$30.00
6-DIGIT GPS CLOCK DRIVER	JUNE 2009	07106091	**$20.00**
UHF ROLLING CODE TX	AUG 2009	15008091	$10.00
UHF ROLLING CODE RECEIVER	AUG 2009	15008092	$45.00
6-DIGIT GPS CLOCK AUTODIM ADD-ON	SEPT 2009	04208091	**$5.00**
STEREO DAC BALANCED OUTPUT BOARD	JAN 2010	01101101	$25.00
DIGITAL INSULATION METER	JUN 2010	04106101	$25.00
ELECTROLYTIC CAPACITOR REFORMER	AUG 2010	04108101	**$40.00**
ULTRASONIC ANTI-FOULING FOR BOATS	SEP 2010	04109101	$25.00
HEARING LOOP RECEIVER	SEP 2010	01209101	$25.00
S/PDIF/CDAX TO TOSLINK CONVERTER	OCT 2010	01210101	$10.00
TOSLINK TO S/PDIF/CDAX CONVERTER	OCT 2010	01210102	$10.00
DIGITAL LIGHTING CONTROLLER MASTER UNIT	OCT 2010	16110101	**$10.00**
DIGITAL LIGHTING CONTROLLER SLAVE UNIT	OCT 2010	16110102	**$25.00**
HEARING LOOP TESTER/LEVEL METER	NOV 2010	01111101	$25.00
UNIVERSAL USB DATA LOGGER	DEC 2010	04112101	$25.00
HOT WIRE CUTTER CONTROLLER	DEC 2010	18112101	$10.00
433MHZ SNIFFER	JAN 2011	08101111	$10.00
CRANIAL ELECTRICAL STIMULATION	JAN 2011	99101111	**$25.00**
HEARING LOOP SIGNAL CONDITIONER	JAN 2011	01101111	$25.00
LED DAZZLER	FEB 2011	16102111	**$15.00**
12/24V 3-STAGE MPPT SOLAR CHARGER	FEB 2011	14102111	$15.00
SIMPLE CHEAP 433MHZ LOCATOR	FEB 2011	06102111	$5.00
THE MAXIMITE	MAR 2011	06103111	**$15.00**
UNIVERSAL VOLTAGE REGULATOR	MAR 2011	18103111	**$10.00**
12V 20-120W SOLAR PANEL SIMULATOR	MAR 2011	04103111	**$10.00**
MICROPHONE NECK LOOP COUPLER	MAR 2011	01209101	$25.00
PORTABLE STEREO HEADPHONE AMP	APRIL 2011	01104111	**$10.00**
CHEAP 100V SPEAKERLINE CHECKER	APRIL 2011	04104111	$10.00
PROJECTOR SPEED CONTROLLER	APRIL 2011	13104111	$10.00
SPORTSYNC AUDIO DELAY	MAY 2011	01105111	$30.00
100W DC-DC CONVERTER	MAY 2011	11105111	**$15.00**
PHONE LINE POLARITY CHECKER	MAY 2011	12105111	$10.00
20A 12/24V DC MOTOR SPEED CONTROLLER MK2	JUNE 2011	11106111	**$15.03**
USB STEREO RECORD/PLAYBACK	JUNE 2011	07106111	**$20.00**
VERSATIMER/SWITCH	JUNE 2011	19106111	$25.00
USB BREAKOUT BOX	JUNE 2011	04106111	$10.00
ULTRA-LD MK3 200W AMP MODULE	JULY 2011	01107111	$25.00
PORTABLE LIGHTNING DETECTOR	JULY 2011	04107111	**$15.00**
RUDDER INDICATOR FOR POWER BOATS (4 PCBs)	JULY 2011	20107111-4	$80 per set
VOX	JULY 2011	01207111	**$20.00**
ELECTRONIC STETHOSCOPE	AUG 2011	01108111	**$10.00**
DIGITAL SPIRIT LEVEL/INCLINOMETER	AUG 2011	04108111	**$10.00**
ULTRASONIC WATER TANK METER	SEP 2011	04109111	**$15.00**
ULTRA-LD MK2 AMPLIFIER UPGRADE	SEP 2011	01209111	$5.00
ULTRA-LD MK3 AMPLIFIER POWER SUPPLY	SEP 2011	01109111	$25.00
HIFI STEREO HEADPHONE AMPLIFIER	SEP 2011	01309111	**$20.00**
GPS FREQUENCY REFERENCE (IMPROVED)	SEP 2011	04103073	$15.00
GPS FREQUENCY REFERENCE DISPLAY (B)	SEP 2011	04103072	**$15.00**
HEARING LOOP RECEIVER/NECK COUPLER	SEP 2011	01209101	**$10.00**
DIGITAL LIGHTING CONTROLLER LED SLAVE	OCT 2011	16110111	$30.00
USB MIDIMATE	OCT 2011	23110111	**$25.00**
QUIZZICAL QUIZ GAME	OCT 2011	08110111	**$25.00**
ULTRA-LD MK3 PREAMP & REMOTE VOL CONTROL	NOV 2011	01111111	$30.00
ULTRA-LD MK3 INPUT SWITCHING MODULE	NOV 2011	01111112	**$20.00**
ULTRA-LD MK3 SWITCH MODULE	NOV 2011	01111113	$10.00
ZENER DIODE TESTER	NOV 2011	04111111	$20.00
MINIMAXIMITE	NOV 2011	07111111	$10.00
ADJUSTABLE REGULATED POWER SUPPLY	DEC 2011	18112111	$5.00
DIGITAL AUDIO DELAY	DEC 2011	01212111	**$25.00**
DIGITAL AUDIO DELAY Front & Rear Panels	DEC 2011	01212112/3	$20 per set
AM RADIO	JAN 2012	08101121	$10.00
STEREO AUDIO COMPRESSOR	JAN 2012	01201121	$30.00
STEREO AUDIO COMPRESSOR FRONT & REAR PANELS	JAN 2012	01201121P1/2	$20.00
3-INPUT AUDIO SELECTOR (SET OF 2 BOARDS)	JAN 2012	01101121/2	$30 per set
CRYSTAL DAC	FEB 2012	01102121	$20.00
SWITCHING REGULATOR	FEB 2012	18102121	$5.00
SEMTEST LOWER BOARD	MAR 2012	04103121	$40.00

PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
SEMTEST UPPER BOARD	MAR 2012	04103122	$40.00
SEMTEST FRONT PANEL	MAR 2012	04103123	$75.00
INTERPLANETARY VOICE	MAR 2012	08102121	$10.00
12/24V 3-STAGE MPPT SOLAR CHARGER REVA	MAR 2012	14102112	$20.00
SOFT START SUPPRESSOR	APR 2012	10104121	$10.00
RESISTANCE DECADE BOX	APR 2012	04104121	$20.00
RESISTANCE BOX PANEL/LID	APR 2012	04104122	$20.00
1.5AW INDUCTION MOTOR SPEED CONT. (New V2 PCB)	APR (DEC) 2012	10105122	$35.00
HIGH TEMPERATURE THERMOMETER MAIN PCB	MAY 2012	21105121	$30.00
HIGH TEMPERATURE THERMOMETER Front & Rear Panels	MAY 2012	21105122/3	$20 per set
MIX-IT-I 4 CHANNEL MIXER	JUNE 2012	01106121	$20.00
PIC/AVR PROGRAMMING ADAPTOR BOARD	JUNE 2012	24105121	$30.00
CRAZY CRICKET/FREAKY FROG	JUNE 2012	08109121	$10.00
CAPACITANCE DECADE BOX	JULY 2012	04106121	$20.00
CAPACITANCE DECADE BOX PANEL/LID	JULY 2012	04106122	$20.00
WIDEBAND OXYGEN CONTROLLER MK2	JULY 2012	05106121	$20.00
WIDEBAND OXYGEN CONTROLLER MK2 DISPLAY BOARD	JULY 2012	05106122	$10.00
SOFT STARTER FOR POWER TOOLS	JULY 2012	10107121	$10.00
DRIVEWAY SENTRY MK2	AUG 2012	03107121	**$15.00**
MAINS TIMER	AUG 2012	10108121	$10.00
CURRENT ADAPTOR FOR SCOPES AND DMMS	AUG 2012	04108121	$20.00
USB VIRTUAL INSTRUMENT INTERFACE	SEPT 2012	24109121	**$25.00**
USB VIRTUAL INSTRUMENT INT. FRONT PANEL	SEPT 2012	24109122	**$25.00**
BARKING DOG BLASTER	SEPT 2012	25108121	$20.00
COLOUR MAXIMITE	SEPT 2012	07109121	$20.00
SOUND EFFECTS GENERATOR	SEPT 2012	09109121	$10.00
NICK-OFF PROXIMITY ALARM	OCT 2012	03110121	$5.00
DCC REVERSE LOOP CONTROLLER	OCT 2012	09110121	$10.00
LED MUSICOLOUR	NOV 2012	16110121	$25.00
LED MUSICOLOUR Front & Rear Panels	NOV 2012	16110121	$20 per set
CLASSIC-D CLASS-D AMPLIFIER MODULE	NOV 2012	01108121	$30.00
CLASSIC-D 2 CHANNEL SPEAKER PROTECTOR	NOV 2012	01108122	$10.00
HIGH ENERGY ELECTRONIC IGNITION SYSTEM	DEC 2012	05110121	$10.00
USB POWER MONITOR	DEC 2012	04109121	$10.00
1.5kW INDUCTION MOTOR SPEED CONTROLLER (NEW V2 PCB)	DEC 2012	10105122	$35.00
THE CHAMPION PREAMP and 7W AUDIO AMP (one PCB)	JAN 2013	01109121	$10.00
GARBAGE/RECYCLING BIN REMINDER	JAN 2013	19111121	$10.00
2.5GHz DIGITAL FREQUENCY METER – MAIN BOARD	JAN 2013	04111121	$35.00
2.5GHz DIGITAL FREQUENCY METER – DISPLAY BOARD	JAN 2013	04111122	$15.00
2.5GHz DIGITAL FREQUENCY METER – FRONT PANEL	JAN 2013	04111123	$45.00
SEISMOGRAPH MK2	FEB 2013	21102131	$20.00
MOBILE PHONE RING EXTENDER	FEB 2013	12110121	$10.00
GPS 1PPS TIMEBASE	FEB 2013	04103131	$10.00
LED TORCH DRIVER	MAR 2013	16102131	$5.00
CLASSIC-D4 MAIN PCB	APR 2013	01102131	**$30.00**
CLASSIC DAC FRONT & REAR PANEL PCBs	APR 2013	01102132/3	**$25.00**
GPS USB TIMEBASE	APR 2013	04104131	$15.00
LED LADYBIRD	APR 2013	08103131	$5.00
CLASSIC-D 12V to ±35V DC/DC CONVERTER	MAY 2013	11104131	$15.00
DO NOT DISTURB	MAY 2013	12104131	$10.00
LF/HF UP-CONVERTER	JUN 2013	07106131	$10.00
10-CHANNEL REMOTE CONTROL RECEIVER	JUN 2013	15106131	$15.00
IR-TO-455MHZ UHF TRANSCEIVER	JUN 2013	15106132	$7.50
"LUMP IN COAX" PORTABLE MIXER	JUN 2013	01106131	$15.00
L'IL PULSER MKII TRAIN CONTROLLER	JULY 2013	09107131	$15.00
L'IL PULSER MKII FRONT & REAR PANELS	JULY 2013	09107132/3	$20.00/set
REVISED 10 CHANNEL REMOTE CONTROL RECEIVER	JULY 2013	15106133	$15.00
INFRARED TO UHF CONVERTER	JULY 2013	15107131	$5.00
UHF TO INFRARED CONVERTER	JULY 2013	15107132	$10.00
IP20 CHARGER	AUG 2013	14108131	$5.00
PC BIRDIES	AUG 2013	08104131	$10.00
RF DETECTOR PROBE FOR DMMs	AUG 2013	04107131	$10.00
BATTERY LIFESAVER	SEPT 2013	11108131	**$4.00**
SPEED CORRECTOR	SEPT 2013	06109131	$10.00
SIDRADIO (INTEGRATED SDR) Main PCB	OCT 2013	06109131	$30.00
SIDRADIO (INTEGRATED SDR) Front & Rear Panels	OCT 2013	06109132/3	$25.00/pr
TINY TIM AMPLIFIER (came PCB as Headphone Amp (Sept'11))	OCT 2013	01309111	**$20.00**
AUTO CAR HEADLIGHT CONTROLLER	OCT 2013	03111131	$10.00
GPS TRACKER	NOV 2013	05112131	$15.00
STEREO AUDIO DELAY/DSP	NOV 2013	01110131	$15.00
BELLBIRD	DEC 2013	08112131	$10.00
PORTAPAL-D MAIN BOARDS	DEC 2013	01111131-3	$35.00/set
(for CLASSIC-D Amp board and CLASSIC-D DC/DC Converter board refer above [Nov 2012/May 2013])			
LED PARTY STROBE (also for Hot Wire Cutter [Dec 2010])	JAN 2014	16100141	$7.50
BASS EXTENDER Mk2	JAN 2014	01112131	$15.00
L'IL PULSER Mk2 Revised	JAN 2014	09107134	$15.00
10A 230VAC MOTOR SPEED CONTROLLER	FEB 2014	10102141	**$12.50**
MICAO/NIMH BURP CHARGER	MAR 2014	14103141	$15.00
RUBIDIUM FREQ. STANDARD BREAKOUT BOARD	MAR 2014	04105141	$10.00
USB/RS232C ADAPTOR	APR 2014	07103141	$5.00
MAINS FAN SPEED CONTROLLER	MAY 2014	10104141	$10.00
RGB LED STRIP DRIVER	MAY 2014	16105141	$10.00
HYBRID BENCH SUPPLY	MAY 2014	18104141	$20.00
2-WAY PASSIVE LOUDSPEAKER CROSSOVER	JUN 2014	01205141	$20.00
NEW THIS MONTH:			
TOUCHSCREEN AUDIO RECORDER	JULY 2014	01105141	$12.50
THRESHOLD VOLTAGE SWITCH	JULY 2014	99106141	$10.00
MICROMITE ASCII VIDEO TERMINAL	JULY 2014	24107141	$7.50
FREQUENCY COUNTER ADD-ON	JULY 2014	04105141a/b	$15.00

Vintage Radio

By Rodney Champness, VK3UG

The upmarket 1950 HMV R53A radiogram

For many well-off families, an expensive radiogram was the focal point of the family lounge room in the era from the late 1920s up until the late 1960s. It not only provided the entertainment but was also an impressive piece of furniture.

RADIOGRAMS were first developed in the late 1920s and were produced in various formats up until the 1960s when TV took over as the main source of family entertainment. During that time, they evolved from very basic units with a record player on top of the cabinet to units that had automatic record changers alongside the radio section.

Some of the very latest units also included a TV set and/or a tape recorder and some even had a cocktail section for good measure!

Of course, not all radiograms were created equal and the quality of the cabinets varied considerably. Some were impressive units made of solid high-quality timber, with timber veneers where necessary. These sets were quite imposing and were heavy but there were also many cabinets that were built to a price and were much lighter.

The radio chassis used also varied considerably in quality. Most units used a cheap and cheerful bog-standard 5-valve mantel receiver chassis driving a large speaker mounted on a baffle board. These sets often had a rather restricted audio frequency range, otherwise hum would have been quite obvious due to minimal high-tension supply ripple filtering and inadequate (or non-existent) shielding of sensitive audio leads.

By contrast, the more expensive top-of-the-line radiograms used a better-engineered chassis designed to give high-quality sound and capable of driving the speaker to high volume. These sets also generally had better RF sensitivity and stability than their cheaper counterparts.

This was achieved by increasing the filtering on the HT (high-tension) line, adequate shielding of critical leads and higher-quality audio output transformers. The audio amplifier was also beefed up, often by using a push-pull audio output stage.

Two Australian-made radiograms that were excellent performers were the STC A8551 from 1955 (featured in the January 2010 issue of SILICON CHIP) and the HMV R53A which came onto the market in 1950. The R53A described here had quite a few problems when it was obtained by its owner and was passed on to the author so that the chassis could be restored.

HMV R53A radiogram

Basically, the owner wanted to be sure that the chassis could be repaired before he undertook the cabinet restoration. As shown in the photos, the R53A is quite a large unit, with the radio chassis and the record changer

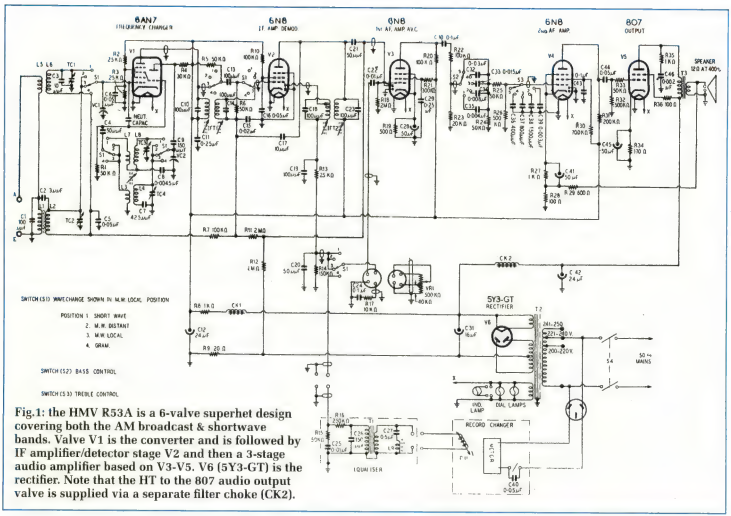


Fig.1: the HMV R53A is a 6-valve superhet design covering both the AM broadcast & shortwave bands. Valve V1 is the converter and is followed by IF amplifier/detector stage V2 and then a 3-stage audio amplifier based on V3-V5. V6 (5Y3-GT) is the rectifier. Note that the HT to the 807 audio output valve is supplied via a separate filter choke (CK2).

mounted side-by-side in separate compartments. These compartments are accessed by opening separate doors which hinge down.

It's interesting to note that the same chassis was also used in a variant which had a top-opening lid to gain access to the controls and the record changer. This was probably a down-market version as the cabinet is not as large and is somewhat lighter than the R53A's.

As it came to me, the R53A radiogram featured here was 64 years old. Its chassis was covered in dust and when I removed it, I could find only one resistor and one capacitor that had been previously replaced, along with a section of the dial cord. However, the original record changer had obviously proved to be less than reliable and had been replaced by a more modern BSR unit at some time in the past.

Circuit details

Fig.1 shows the circuit details of the HMV R53A. It's a 6-valve superhet design and covers the AM broadcast band (nominally 540-1600kHz) plus the shortwave band from 6-18MHz. The broadcast band tuning range specified is what was allocated in the 1940s and 1950s but in practice, the R53A tunes a slightly wider range of frequencies from 530-1660kHz.

As shown in Fig.1, the antenna coil's primary windings are in series with each other, with the shortwave coil acting as a low-value loading coil for the antenna.

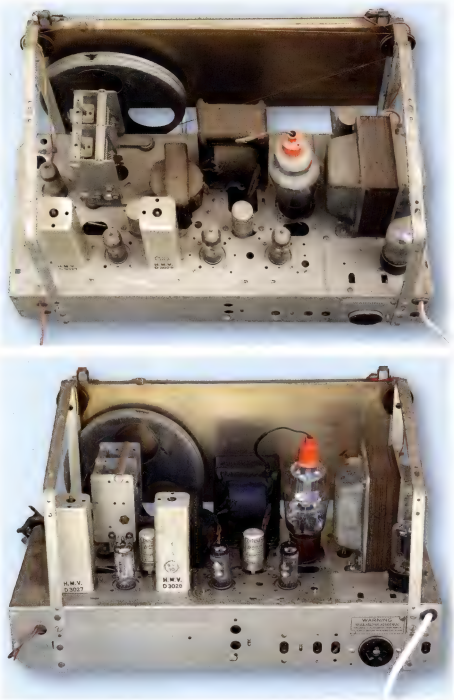
The broadcast coil primary winding resonates below the broadcast band due to the combination of L1 & C1. This gives improved performance at the low-frequency end of the band. The 3pF capacitor (C2) between the primary and secondary windings (L1 & L2) improves the performance at the high-frequency end of the broadcast band.

Unlike the broadcast-band coils, the shortwave coils (L5 & L6) do not use any elaborate coupling methods. That's because any antenna likely to be employed would have sufficient length to be resonant on some portion of the shortwave band. L5 is in series with L1 and although L1 will act as an RF choke on shortwave, C1 (100pF) acts as a low-impedance path to earth for the 'earthy' side of L5. This was a neat trick that was used by many manufacturers; it worked well and saved a switch section.

The antenna coils are switched as appropriate in the grid circuit of converter valve V1, depending on the band selected. Alternatively, V1's grid is shorted to chassis when the set is switched to 'Gram', to prevent RF signals breaking through.

R4 and C9 ensure that no high voltages are present in the oscillator's tuned circuits. This method was used by many manufacturers but others have the oscillator plate current flowing through the feedback winding. Either method works well but you do have to be aware that high voltages are present in the tuned circuits of some oscillator stages.

The converter stage is neutralised using a small 'gimmick' capacitor between the oscillator grid and the



These two views show the chassis before and after restoration. Note the insulated cap (red) on the top of the 807 output valve. This is the plate connection and must not be touched due to the shock hazard.

signal input grid. This 'gimmick' capacitor was made using about 20mm of insulated bell wire.

The 457.5kHz IF (intermediate frequency) appears at V1's plate and is fed to the primary winding of IF transformer IFT1. It also goes to a section of 4-position switch S1, which is the band change and 'Gram' selector switch.

In positions 1 & 2, the IF transformer is coupled in the conventional manner. However, when S1 is in position 3, resistor R10 is switched across IFT1's primary while R6 is switched across the secondary winding. Capacitor C13 is also connected between V1's plate and V2's grid.

These switched parts lower the Q of the tuned circuits and, along with the heavy top-coupling due to C13, give a wide frequency response with a dip in the middle. IFT2 (which follows V2) also has a wide response and this means that signals out to about 10kHz are amplified with little attenuation of the higher audio frequencies.

V2, a 6N8, amplifies the IF signal and, like the converter, this stage is also neutralised. This is done by C17 in conjunction with C15. The signal at the output of IFT2 is fed to the detector diode in V2. The resulting audio signal is then fed to another section of switch S1 which selects the audio signal from either the radio or the record changer and feeds it to a 4-pin socket. The volume control is wired to this socket and its output is then fed back via this socket to the input of V3, another 6N8.

It's difficult to understand why the volume control was attached via a plug and cable to the chassis and not mounted on the front of the chassis like the other controls. In this case, the volume control is mounted on a side panel of the radiogram, possibly so that it could be accessed with the door to the radio section closed.

V3 amplifies the volume control signal and in turn drives separate bass and treble control networks. The resulting signal then goes to V4, another 6N8, which further amplifies the signal before feeding it via C44 to the grid of an 807 output valve (V5).

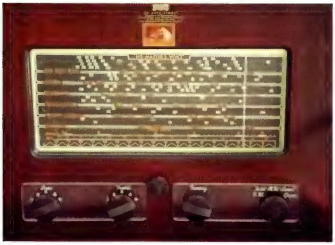
V5 again amplifies the audio signal and then feeds it via a substantial audio transformer to a 12-inch (~30cm) loudspeaker. This circuit includes voice-coil negative feedback which is fed back to the cathode circuit of V4. Note that the 807 is not bypassed at the screen but via a 100Ω resistor (R36). Some valves, including the 807, can be unstable if they are not bypassed in this manner.

The power supply is based on full-wave rectifier V6 (5Y3-GT) and is quite conventional. The HT (high tension) line has two filter chokes (CK1 & CK2), with CK2 feeding just the 807 output valve (V5) and CK1 feeding HT to the remainder of the receiver. Note that back bias is applied from the top of resistor R9 to the AGC diode in V3 and to the grids of V1 & V2.

Conventional delayed AGC is used with -2V of delay. As a result, both V1 & V2 are biased at -2V, as is the AGC diode in V3. No additional bias is developed until the IF signal at the plate of the AGC diode exceeds 2V peak.

Restoring the chassis

Removing the R53A's chassis from



The two tone controls, the tuning control and the band-switch are mounted just below the dial, while the volume control is mounted on a side-panel of the cabinet.

The original record changer had obviously given trouble because it had been swapped out for this more-modern BSR unit. It sits on a shelf that slides out of the cabinet.

the cabinet is quite straightforward. First, the plywood sheet covering the back of the receiver is removed, then the knobs are removed by pulling them off their spindles. The volume control is then removed by unplugging its cable from the socket on the top of the chassis, then undoing the three screws which secure it to the side of the chassis.

Next, the four screws underneath the chassis shelf are removed and various leads at the back of the chassis disconnected (ie, antenna/earth leads, speaker lead, record changer leads, etc). The 'on' light lead to the bottom of the cabinet must also be disconnected. This entire procedure takes just few minutes.

Once it was out of the cabinet, the chassis was carefully dusted using a paintbrush and cleaned with a kerosene-soaked rag. This also worked wonders on the black sealing material used on the transformers. The cabinet was then brushed down and a damp sponge used to remove any ingrained dust from the woodwork.

There was no corrosion to any extent and the chassis looked quite presentable. This old HMV R53A has obviously been stored in a dry environment to still be in such condition.

As is my usual practice, my next step was to remove all the valves and wash them in warm soapy water. The miniature valves were simply dunked in the water and the glass envelopes rubbed clean. However, you have to be careful not to remove the type markings, as these can easily be rubbed off. These valves were then rinsed under clean water and allowed to dry.

Valves like the 5Y3GT and the 807 have Bakelite bases and have to be treated more carefully. For these types, the valves were simply turned upside-down and the envelopes carefully washed while taking not get any water into the bases. They were then rinsed with clean water and left to dry upside-down.

Replacing faulty parts

The next job was to replace all the electrolytic capacitors and any paper capacitors that were excessively leaky. The paper capacitors were tested for leakage using a high-voltage insulation tester. This tester was then set to its 1000V range and used to check the insulation of the power transformer. In this case, the resistance from the mains winding to earth was found to be in excess of 100MΩ, which is quite satisfactory.

In order to maintain the original appearance, the faulty electrolytic capacitors on the top of the chassis were left in place but were disconnected from the circuit. New capacitors were then fitted in place under the chassis. The most critical capacitor is the one connected to the 5Y3GT as this rectifier doesn't 'like' high surge currents flowing through it. In this case, C31 was initially replaced with a 10µF 525V capacitor (see below).

The two components (one resistor and one capacitor) that had been replaced earlier in the set's life had failed again and so new parts were substituted for these. A couple of other resistors were also found to be well out of tolerance and were also replaced.

That done, the dial mechanism and all the movable controls were lubricated using either light machine oil or Inox® lubricant. These controls then all worked smoothly and were free of mechanical noise. The original 2-core power lead was also replaced with a securely anchored 3-core lead so that the chassis could be safely earthed.

Getting it going

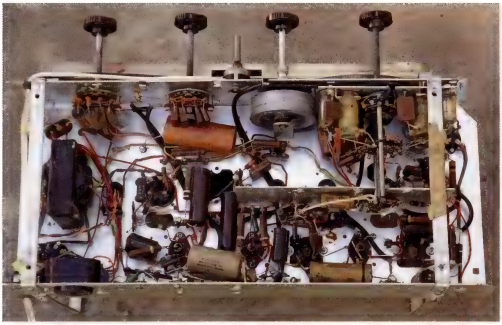
It was now time for a smoke test (well, actually I hoped that there wouldn't be any smoke).

First, the loudspeaker was removed from its baffle inside the cabinet and connected to the receiver, along with an antenna and earth. The HT line was then checked for any shorts to chassis, after which the set was connected to mains power and switched on with the multimeter now monitoring the HT voltage.

It was all something of an anti-climax because the HT voltage rose and settled down as expected. Because the 5Y3-GT heats up more quickly than the other valves in the set, the HT initially rises up to around 400V before settling down to about 290V out of the rectifier when the other valves warm up. As expected, the HT is somewhat lower when measured at the filter capacitors following the two filter chokes.

Once the valves had warmed up, the set then burst into operation and it sounded quite good except that hum was evident in the audio. The cause wasn't hard to find – I had replaced filter capacitor C31 with a 10µF unit which was inadequate for this set.

I tried replacing this capacitor with the only 16µF capacitor I had but the hum was still quite evident. I then



All the parts under the chassis of the HMV R53A are readily accessible. This view shows the chassis prior to restoration – some parts were replaced to get the set going, while the 2-core mains cable was later replaced with a 3-core cable so that the chassis could be earthed.

installed a 22μF capacitor across C12 but it was still not enough so I decided to try decoupling the plate and screen leads to V3. This involved installing a 4.7μF capacitor between the junction of R20 & R21 and chassis, plus a 10kΩ resistor from R20/R21 to C12.

That finally reduced the hum to quite a low level, such that it was just audible with my ear near the speaker cone and with the volume control turned right down.

The set goes dead

The hum problem had no sooner been solved when the set suddenly went dead. There was no audio so there was clearly something wrong with the audio amplifier stage.

A few quick checks showed that while there was plenty of voltage on the plate and screen of the 807 output valve, there was no voltage drop across its cathode resistor. Substituting another 807 cured the problem, so that problem was easily solved.

By the way, the 807 valve is a moderately-large 5-pin valve that was originally designed for use in medium-sized communications transmitters during the 1940s. And here a word of warning: if a set uses an 807 and there is no protective top cap cover on the connector, don't be tempted to put your finger on it while the set is operating (ie, while power is applied). This is the plate terminal, not the grid, and you will get a nasty high-voltage shock if you do.

Although the set was quite sensitive, further checks revealed that very little AGC voltage was being developed between the junction of R7 & R11 and the chassis. I had expected around 10V of AGC when the set was tuned to a local broadcast station but I was only getting about 2.5V.

I checked the voltages around valves V1 & V2 and they appeared normal so I tried substituting a new 6N8 for V2 and the performance improved quite noticeably. The AGC voltage also shot up to somewhere near the expected level. The chassis was then left on test for quite a few hours to make sure there were no further problems lurking in the background.

Checking the alignment

The next step was to check the alignment. First, I tried tweaking the antenna trimmers on both the broadcast and shortwave bands but couldn't improve the performance, so the original settings were retained. However, when I checked the IF amplifier, I found that the centre of the IF passband changed by about 4kHz when I switched S1 between the distant and local positions.

This shift in the passband centre is caused by the top coupling between the two tuned circuits in the first IF transformer. If the set had used bottom coupling instead, the frequency shift would have been in the opposite direction. This means that the best method of maintaining the same centre frequency is to have both top and bottom coupling between the two tuned circuits.

In the end, by carefully adjusting the IF alignment, I was able to minimise this effect and get close to a common passband frequency centre for the local and distance switch positions.

Record changer repairs

Observing the operation of a record changer mechanism isn't normally an easy job. However, back in the October 2000 issue of SILICON CHIP, I described a home-made servicing aid which allowed a changer to sit up on 300mm-high dowels, so that the mechanism could be observed during operation.

As shown in one of the photos, I also used this device when I overhauled the R53A's changer. As mentioned, the original changer had obviously given trouble because it had been replaced with a more-modern BSR unit.

The biggest problem with this changer turned out to be the pick-up cartridge – it simply had no output. Unfortunately, a direct replacement is now almost impossible to obtain and after looking through many catalogs, the only generic pick-up that was suitable was listed by WES Components of Ashfield in Sydney.

It wasn't a drop-in replacement, however, and the tone-arm mounting had to be carefully modified so that it could be installed properly. It wasn't a difficult job but it did take more time than expected.

Stylus pressure

One thing that's important with the pick-up is to correctly adjust the stylus pressure. Up-market hifi turntables may specify just 1.5g to 3g of stylus pressure, whereas most record changers intended for the broad consumer market have stylus pressures of 5-7g. If more than this is required to get the tone-arm to track the record properly, then the sliding surfaces in the mechanism probably need lubricating.

The downward stylus pressure is controlled by either a spring at the vertical pivot point of the tone-arm or, in some cases, the weight has to be adjusted at the head. In this case, the new pick-up was lighter than the original, so I had to add some weight

Now that the radio and record changer have been repaired, the next job is the cabinet restoration. One of the bottom doors is missing and will have to be made.

into the shell where the cartridge is located. Some shells already have weights installed but if not, metal washers can sometimes be used to increase the pressure on the stylus.

I didn't have a stylus pressure gauge, so I used our digital kitchen scales to get the weight correct. These scales can measure down to 1g, which is good enough for this job.

Having set the stylus pressure, I then cleaned any old congealed grease off various surfaces and applied fresh, light grease in its place. The motor bearing and various pulley bearings were then oiled. This was relatively straightforward although I did have to dismantle the motor to gain access to its bearings. In fact, this should be done every few years as these motors can seize up if they are not lubricated and this particular unit was very close to that point.

The various other adjustments on the changer were all spot on. The stylus drop-in point was correct, the speed change mechanism worked well and the record dropping and cut-out mechanisms all worked as they should. BSR record changers were relatively simple compared to some other brands and it is rare for them to have any major problems.

Summary

For its time (circa 1950), this is one of the best radiograms I have ever worked on. The receiver section is quite sensitive, the dual-bandwidth IF amplifier works well, the audio output is more than adequate and the audio bandwidth and clarity are excellent. And once the owner finishes the cabinet restoration, the old HMV R53A will look great too.

The chassis is also easy to work on and is well laid out, with most components easily accessible. HMV used lots of plastic-sheathed shielded audio and RF cables which were only earthed at one end to prevent induced hum from the heater circuits.

The record changer was serviced by sitting it on top of this homemade jig.

One very worthwhile feature is a 'rollover cage' over the top of the chassis. This makes it easy to tip the set over for servicing without risking damage to fragile parts such as valves.

The circuitry also shows considerable attention to detail and includes neutralised IF amplifier and converter stages to ensure stability. It certainly ticks most of the boxes for good design. The chassis was also obviously designed to accommodate a number of sets of the era as there is an extra cut-out for an additional IF transformer and the power transformer is mounted on a plate at one end of the chassis.

In fact, I have a HMV model 268 receiver which started life as a vibrator-powered set but was converted to 230VAC operation as described in May 2000. Its chassis layout is almost identical to the R53A's, so HMV had developed a layout that worked well for many quite different models.

If you have the room and want to enjoy the sound from one of the better early radiograms you couldn't go past the HMV R53A. And if it had been fitted with a dual-cone speaker it probably would have sounded even better than it already does. SC

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Send your email to silicon@siliconchip.com.au

Why is amplifier clipping a problem?

I just read the article on the Majestic loudspeaker in the June 2014 issue and it looks very good. One thing I would like to ask about is the statement on page 31 that even a relatively small amplifier can damage a high power speaker if the amplifier is clipping badly. Yet on page 25 you show the speaker being driven by a square wave signal, which is pretty much what a clipping amplifier would produce.

One can only presume that this test signal is at a low level. Leaving aside tweeters and the excessive harmonics that would be fed to them, just why are woofers, at least, vulnerable to clipping? After all, if an amplifier can produce a 100W sinewave without clipping and a speaker can thermally tolerate 300W continuously, if the amplifier then outputs a square wave at the same peak voltage as before, then it will deliver exactly double the power to the speaker. What is the danger here? (G. P., Hampton Park, Vic).

● The square-wave signal shown on the scope is of quite a low amplitude, at level of about 1W or so.

While an amplifier may only deliver double its nominal power output when driven into hard clipping, it can blow a speaker which is rated to handle the nominal output on normal music signals. Such ratings are quite short term and delivering a much bigger burst can damage the speaker. It probably won't burn out the voice coil but it might well lead to a loose turn on the voice coil which will result in "poling" and make the speaker unlistenable.

Alternatively, a big burst of low-frequency signal could conceivably lead to the voice coil jumping out of the gap and again cause it to "pole".

On the other hand, if you over-drive a 100W amplifier into a speaker rated to handle 300W, then it should not be a problem.

Query on LED Party Flash

Your circuit for this LED Party Flash strobe in the January 2014 issue does not appear to have any constant-current drive to the LED array. I had always thought that LEDs needed to be driven with some form of current limit as they are a temperature variable constant voltage device. (I. T, Duncraig, WA).

● You are right in that LEDs and LED arrays generally need some form of current limiting. In this case, it is the impedance of the supply filter capacitor and the transformer which limits LED current. You can see this from the scope grab; when the LED turns on the supply filter capacitor quickly discharges and never fully recharges again until the LED switches off.

It's possibly a good idea to have some other form of current limiting in the circuit to limit the peak LED current, especially at the moment of switch on, which is why the PCB has provision for a 5W resistor to be connected in series with the load. A resistor with a value of a couple of ohms would be about right. This should have little effect on the brightness but waste a little power.

LEDs don't operate with a constant voltage as such; it's just that they have a sharp knee like other diodes, ie, beyond a threshold, a small change in voltage causes a large change in current flow. But they also have some intrinsic resistance. That is what we're taking advantage of in this case, limit-

Connecting The Tiny Tim Amplifier To A TV Set

I plan to build the Tiny Tim stereo amplifier (Silicon Chip, October & December 2013, January 2014). As I intend to use it with my flat-panel TV, would I be connecting the TV to the Tiny Tim unit via the TV's headphone jack? Assuming that the signal from the TV's headphone jack is analog, I would then have no need to install the DAC (digital-to-analog converter) into the Tiny Tim unit.

I also note that in part 2 in December 2013, Fig.6 shows that a tin-plate shield is to be affixed between inductors L3 & L4 on the main PCB (code 01309111) and instructions are given in the text regarding its installation.

However, a PCB coded 01106111 is depicted in the photographs in all three articles and with all the components installed, there is no tin-plate shield visible between inductors L3 & L4. So, is the tin-plate shield only required for the 01309111 PCB, or is it not required at all on either board? (C. B., Coffs Harbour, NSW).

● It depends on the TV but in many cases you can use the headphone output to drive an external amplifier. Some headphone outputs may require a low-impedance load to operate correctly but most don't. If there is a problem, you could connect a resistor (say 100Ω 1W) across the output to simulate a headphone load but we would try it without first.

In fact, we recently connected the Compact 12V Stereo Amplifier (Silicon Chip, May 2010) to a Blaupunkt TV via the headphone output using a 3.5mm stereo plug to 2 x RCA cable and it worked well. It allowed the volume to be altered using the remote.

The tin-plate shield isn't a terribly critical component and as you noticed, it wasn't present on the original prototype PCB that we used. It's up to you whether you fit it; it's supposed to increase channel separation and reduce distortion by preventing the magnetic fields of the two inductors from interacting but the difference is marginal. On the other hand, it isn't difficult to fit.

Can The Barking Dog Blaster Scare Kangaroos?

With reference to your article on the Barking Dog Blaster (SILICON CHIP, September & October 2012), I wonder if you have considered further applications for this type of thing. I'm looking at animal repellers for 4WD vehicles and am mainly thinking of kangaroo avoidance.

Whilst there are some commercial ultrasonic units available they seem to be of questionable value. Internet research would have it that they are only effective on wild animals which are not used to the sound whereas tame animals simply ignore the noise.

They also only work at speeds under about 80km/h, presumably due to the low power output not penetrating very far ahead of the vehicle. The Barking Dog Blaster, running at a frequency humans can't hear, might be a good solution, with lots of acoustic power to alert animals that something unusual is about to occur.

Your thoughts on this please? (M. M., via email).

● While the Barking Dog Blaster is reasonably effective at reducing the nuisance of barking dogs, we have serious doubts that it would be useful as a kangaroo deterrent. While kangaroos may react to the ultrasonic sound and would hear it at the same time as they hear the on-coming vehicle, there is no way of predicting how they would react. After all, we must assume that all kangaroo accidents must be the result of the kangaroo suddenly reacting and darting off in the wrong direction, into the path of the vehicle.

Your point about the penetration of the acoustic warning is also valid. You would want the acoustic noise to be intolerable to the kangaroo at a distance of at least 50 metres (which a vehicle travelling at 80km/h would take only two seconds to traverse). Obtaining an effective range of 50 metres would require a lot more power than is available in our Barking Dog Blaster.

ing the peak current to a reasonable value from what is (at least briefly) a voltage source.

WAV files sound better than MP3

Why did you choose to save the audio files in the "Touch-Screen Digital Audio Recorder" now being presented as ".wav" files rather than what I would have thought was the more commonly used ".mp3" format?

Is the unit's firmware upgradeable, as needed and if so, does the possibility exist to upgrade it to perhaps handle either ".wav", ".mp3" or both, as user options when configuring the unit or does the CODEC unit only come with ".wav" capability? (P. M., Karabar, NSW).

● The use of WAV files comes down to three things: better audio quality, simpler/cheaper circuitry and less processing required.

There have been a number of occasions when we have been playing MP3 files in the laboratory (due to not having anything better handy) and Leo Simpson has walked in and said "that sounds awful" – and these were originally very good quality recordings. The files were converted from CD to MP3 at quite a high bit rate (around 192kbps) using a well-regarded MP3 encoder.

We have to agree with him that MP3s do not sound anywhere near as good as the CD-quality source. Transients seem much more muddled and sounds like cymbals, hi-hats and clapping are distorted and muddy.

Part of the reason for doing this project when cheap smart-phones can already record and play back audio was that Andrew Levido's device would have better sound quality. If he'd used the MP3 file format that advantage would have been largely negated.

Also, encoding MP3 in real time is a processor-intensive task, especially if the result is to sound any good. Thus the unit would require either a VS1063 encoder/decoder IC interfaced to the existing microcontroller or a substantially more powerful microcontroller (running at a minimum of several hundred megahertz) to do the job. Both would likely increase the current drain and cost/complexity.

On the other hand, while WAVs are several times larger than MP3s, a cheap SD card can fit many hours of CD-quality audio recorded in WAV format.

We could perhaps do a recorder in the future that supports MP3. However, if sound quality is important, WAV and FLAC are still the best formats.

DC-DC converter for the Tiny Tim amplifier

I am thinking of building the Classic-D DC-DC Converter (SILICON CHIP, May 2013) to power the Tiny Tim Amplifier. Can the converter be adjusted down from the intended output of ±35V, to provide the ±20V rails that the Tiny Tim requires? Also, can the PCB of the converter be included in the same enclosure with the Tiny Tim board, without the shielding provided by the metal diecast case?

If shielding is necessary, can it be confined to just the transformer T1? I would be providing Mosfets Q1 and Q2 with heatsinks. (C. B., via email).

● Yes the DC-DC Converter could be used. The secondary windings would need to be 15 turns instead of 21 turns. The fuse should be changed to 5A.

You may need to shield the DC-DC Converter from the amplifier input stages if it is located in the same box but it would be the earthing that has the most impact on noise. A single point earth on the chassis should be used for the 12VDC input negative terminal and the 0V supply earth.

The signal earth may need to also connect to the chassis at the signal input.

UHF remote control compatibility

Just wondering if you could help me with some information on the Altronics K1957 UHF transmitter kit. I'd like to find out if it would be compatible with other UHF receiver/relay kits, eg, the Jaycar LR8855?

I don't need all the features of the Altronics receiver kit but I would like a transmitter kit that I can fit into a ruggedised case for use with a 4X4 winch. (S. C., via email).

● The Altronics K1957 is a rolling code 3-Channel Transmitter that was

Shut-Down Timer For Water Pressure Pump

I have a water tank pressure pump combination to supply water to my home. If a fitting (eg, a join in an irrigation system) fails then the pump will run continuously until the tank is empty, particularly if the house is unattended at the time!

I want to put a timer in place such that, when a tap is turned on and the pump starts, a timer commences to count down a pre-set number of minutes (say, 60) and cuts power to the motor if it is still running. The pump will then remain disabled until it is manually re-enabled. Has SILICON CHIP published anything like this or perhaps you may have something similar which I can modify? (T. C., via email).

● We published a Remote Control Mains Switch in February 2008. The Mains Switch portion can be set to apply power to a mains general purpose outlet (GPO) when the Remote Control Mains Switch is powered up and allow power to the GPO for a preset time period. A one-minute period is available, a more than adequate period for pumps that have a pressure bladder to store pressure and cycle on and off. A longer time-out would be required for pressure-regulated pumps that have digital electronics control and which run continuously when supplying water to a tap.

After the time-out period or when the pressure switch turns off the supply, then power would be disconnected from the GPO.

The Remote Control Mains Switch includes brownout switch-off that is ideal for protecting pumps. The remote control features (such as the UHF remote components) can be omitted from the circuitry.

The Remote Control Mains Switch would need to be wired to be powered via the pump's pressure switch that would normally power the pump directly. Then the Remote Control Mains Switch GPO outlet would power the pump.

Incidentally, the timer idea would also protect the pump from continuous running when the supply tanks run dry. That is common during drought seasons.

published in SILICON CHIP in August and September 2009. The transmitter must be used with the receiver published with this unit (Altronics KC1958). No other receiver will work with the transmitter.

The Jaycar LR8855 is a prebuilt UHF receiver relay board. The separate transmitter (LR8856) matches that receiver. While the LR8855 is also rolling code, the Jaycar K1957 transmitter uses an incompatible rolling code.

With any rolling code transmitter and receiver, you must use a matching transmitter and receiver. They must be also synchronised with the same rolling code sequence to work together. A different transmitter will not work.

Speed controller for a golf buggy

I am looking for a speed controller for a 12V golf buggy which has a 23A motor. I bought a Jaycar kit (KC5502) of the controller from your June 2011 issue and I wonder if I replace the fuse with a 25A one if it is likely to withstand the 23A motor. Can you recommend any other modifications?

My inclination is to make it with a 25A fuse and take the risk. The various components in the actual motor power part of the circuit look as though they should be OK to me. (R. M., via email).

● It would probably be OK but you may need a slow-blow fuse. The motor may well draw more more than 23A at start-up. The PCB tracks for the high current part of the PCB could benefit from paralleling with tinned copper wire between connections to prevent track fusing.

Radio chip for lightning detector

I recently built the lightning detector (SILICON CHIP, July 2011) but I am unable to find the AM radio IC, TA7642. I tried element14 and RS Components but could not find it. Any suggestions where I can purchase it or is there an alternative? (K. P., via email).

● The TA7642 is available from Wiltronics or Futurlec. See the following links: (1) www.wiltronics.com.au/catalogue/357/electronic-components-and-parts/integrated-circuits-%28ics%29/linear/am-radio-ic and (2) www.futurlec.com/Others/TA7642pr.shtml

Assembly query on SemTest project

Can you please clarify a small point with regard to the main PCB in the SemTest semiconductor tester project (SILICON CHIP, February, March & May 2012). Q3, IRF540N and the 7805 regulator are mounted on heatsinks. Should these devices be electrically isolated from the heatsinks?

I would normally use a thermal mounting kit to isolate these ICs but there is no mention of this approach in either the text or the parts list, which makes me a little unsure. (B. D., via email).

● There's no need to electrically isolate either Q3 or the regulator from their heatsinks, with regard to operation of the SemTest. However, if you are ever testing the operation of the main/lower PCB 'out in the open' just make sure that you don't touch the heatsink for Q3 (or short it to ground), as it will give you quite a 'bite' due to the high voltage pulses present on the drain and heatsink tab of Q3 and hence on the heatsink as well.

It would of course be possible to fit an insulating washer and sleeve to isolate Q3's heatsink from its tab and drain, to remove the risk of an accidental 'bite'. However, if you do this, just make sure that you use thermal conducting grease to ensure that Q3 makes good thermal contact with the heatsink.

We decided not to do this because the lower PCB is not normally accessible when the SemTest is in operation.

Tempmaster sensor fault

I have built the Jaycar kit for the Tempmaster Mk.2 (SILICON CHIP, February 2009) and being new to electronics have taken my time and tested it as the instructions suggested. However, I am unable to get the unit to work and not sure why so I hope you're able to point me in the right direction.

I have set the unit to heat and changed the 2.7kΩ resistor to 2.4kΩ. The voltage at TP1 is 2.88V for 15°C and I have tried 2.98V for 25°C. The voltage at T2 is 4.98V.

The voltage to CON3 is 2.86V when TP1 is 2.88V but then when I connect the relay, the voltage drops to 0.02V and the LED goes off. Regardless of the voltage setting, the LED will not go off while the relay is not connected.

I did notice that a black-ringed resistor in the kit is not used? Was it to be the link wire? I used some resistor wire as per the photo in the instructions. I hope you are able to help me. (C. L., via email).

● It sounds as if your temperature sensor TS1 (the LM335Z) is either not connected into circuit via CON2 or is perhaps connected the wrong way around. So we would suggest that you look carefully at the connections at each end of the sensor cable.

The clue to suggesting this as the cause of your Tempmaster Mk2's reluctance to work is your statement that the voltage measured between TP2 and TPG was 4.98V. If the sensor was connected correctly into circuit, this voltage would not be present unless the sensor temperature was raised to 225°C or more: hotter than your soldering iron tip!

Bluetooth interface for the Micromite

I am looking at the Micromite article in the May & June 2014 issues of Silicon Chip with great interest, particularly with regard to the GPS-controlled clock. I already have a GPS unit that transmits its NMEA data via Bluetooth. Is there any chance of Silicon Chip describing a Bluetooth interface for the Micromite? (D. H., Maleny, Qld).

● We do not plan for a specific article on Bluetooth interfacing but it is very easy to do. All Bluetooth receivers (eg, **www.sparkfun.com/products/10253**) put out the data as a serial stream. So all you need do is connect the Bluetooth receiver to one of the COM ports on the Micromite and use the serial I/O functions in MMBasic.

RGB LED Strip Controller Won't Change Brightness

I have just built the RGB LED Strip Controller from the May 2014 issue and it works fine apart from the brightness control having no effect. I have checked that there is a connection between the pot wiper pin and pin 19 of the micro and that the voltage at this pin varies when the pot is rotated.

The low voltage cut-out feature works OK, ie, the ADC associated with ADC7 is working OK. I programmed the microcontroller myself using the hex file from the Silicon Chip website. Any thoughts on what else I should check? (T. W., via email).

● That's a little odd since the code to read the voltage at ADC6 isn't much different from that at ADC7. The brightness control works on our prototype.

Check the solder joint for pin 19 carefully. It's possible that the pin is floating above the pad and not making a connection (unless you press down on it with a probe).

Note: after subsequent correspondence with T. W., he was able to determine that the problem was with the software. In the readADC function, immediately before the lines reading:

```
ADCSRA = (1 << ADEN)|(1 << ADPS2)|(1 << ADPS1)|(1 << ADSC);
loop_until_bit_is_set(ADCSRA, ADIF);
```

It is necessary to insert this line:

```
ADCSRA |= (1 << ADIF);
```

This clears the analog-to-digital converter (ADC) interrupt flag prior to starting a conversion. The software on our website has been updated to version 1610514B and subsequent programmed microcontrollers supplied will have this revised firmware.

The fact that the software worked on our prototype may be due to slightly different revisions of the ATmega48 chip behaving in a different manner with regards to clearing the ADC interrupt flag by writing zero to it.

Classic-D amplifier failed under test

I have built the Classic-D amplifier (Silicon Chip, November & December 2012) from an Altronics kit and it worked perfectly. However, when I was testing it using the Classic-D Speaker Protector, it failed. At the time I was using 1kHz sinewave signal at less than 1V, with an 8Ω 100W resistive load.

All the voltages are OK with the protect jumper LK3 in place, how-

WARNING!

Silicon Chip magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of Silicon Chip magazine.

Devices or circuits described in Silicon Chip may be covered by patents. Silicon Chip disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. Silicon Chip also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Competition & Consumer Act 2010 or as subsequently amended and to any governmental regulations which are applicable.

Capacitance Leakage Meter Has Faulty 100V Range

I built the Capacitance Leakage Meter (SILICON CHIP, December 2009) and it works very well but I have one query. On the 100V scale the current under test with a shorted output is approximately 6.3mA, not 9.9mA which the text suggests is correct.

I have checked all resistors for value and they all measure as specified and are in their correct positions. All other voltage/range currents are very close to that specified in the article. I cannot find any solder bridges, wiring errors or other obvious faults and the meter performs perfectly as described in all other respects. (B. D., via email).

● If the only problem symptom you are getting during the setting-up of the December 2009 Capacitance Leakage Meter is a 'shorted terminals' reading of only 6.3mA on the 100V range, this suggests that the DC-DC converter (based on IC1) cannot provide its 100V output when driving a 10.1kΩ load.

Assuming you have not swapped any resistors in the divider chain around switch S1, the most likely reason for this symptom is that step-up transformer T1 is somehow not functioning properly or perhaps the switching transistor inside IC1 is not able to switch as efficiently as it should.

We suggest measuring the voltage at TP3 while you are doing the 'shorted terminals' test, to see if the voltage drops below the correct figure of 1.25V on the 100V range. If it drops below this figure, this would suggest that you might get an improvement by replacing the 1Ω resistor between pins 6 & 7 of IC1 with one of 0.47Ω. Otherwise, you might be advised to try rewinding T1, to improve the converter's efficiency when providing 100V output.

Of course, if the meter seems to be working fine on all other ranges, you may decide to leave it alone and just accept that the converter can't provide the full '100V at 10.1kΩ loading' on the top range. After all, this isn't likely to be a problem when you are testing most 'good' capacitors – only those that are dirt-tin material.

ever once the protect jumper LK3 is removed the voltage across V_B and V_S is 64V; all the other voltages are OK. First time round it burnt out the 10Ω 1W resistor connected to the series 100nF capacitor. Is it possible that IC1 (IRS2092) is damaged?

My question is can using a test signal before the relay kicks in damage the amplifier? (J. S., Toowoomba, Qld).

● The speaker protector is essentially separate from the amplifier and protects the loudspeaker from DC. The blowing of the 10Ω resistor is not related to the speaker protector being connected.

We don't know what you mean by "voltage across V_B and V_S is 64V". If it means that V_S is 64V with respect to circuit ground (0V) then there is a severe DC problem where possibly Q1 is shorted between drain and source.

Alternatively, if it means that the voltage between V_S and V_B is 64V then that would be normal if IC1 is not starting up.

If the 10Ω resistor fails, it may be that the 100nF capacitor in series has an internal short or is somehow shorted on the PCB.

It could be that one of the pins on the IC is open-circuit to the PCB or there could be a short somewhere between these pins or elsewhere on the board. Or maybe the oscillation frequency is too high. Check the 560pF capacitors at pins 2, 3 & 4.

Also check the isolation between the Q1, Q2 & Q3 tabs and the heatsink.

GPS tracker interferes with car electronics

Having recently installed the GPS Tracker kit (SILCON CHIP, November 2013) in my 2013 model Landcruiser I am having problems with the car's OEM remote control losing the plot. After heaps of diagnosing the problem with the car's remote I finally tracked it down to some type of interference from the GPS Tracker.

Do you have you any clues as to how this problem can be fixed? (J. G., via email).

● This problem is a first for the GPS Tracker so we do not have a quick solution. Most likely, the interference is being created by the switching power regulator and broadcast via the power leads. The fix for this could be a capacitor (say 1μF) wired across the terminal block for the incoming power and a ferrite bead in each power lead close to the GPS Tracker terminal block.

Other things to try would be different power and ground connections and relocating the GPS Tracker to a different physical location.

Lower Power Output For The Ultra-LD Amplifier

I would like to build the Ultra-LD Mk 3 as a 75W unit as this is all I need and a 160VA toroidal transformer will fit into a 1RU rack case. This type of amplifier design will mostly work at lower rail voltages but sometimes linearity performance is sacrificed if significantly lower without some modification. (K. J., Hobart, Tas).

● You don't have to reduce the supply voltage by a large amount to reduce the power output to 75W. Reducing the supply rails to about 45V should do the trick. That means that the transformer secondary voltage needs to be around 64VAC centre-tapped or 32VAC a side.

Some circuit modifications will be necessary: (1) change the 6.8kΩ/1W resistor at the emitter of Q5 to 4.7kΩ; and (2) change the two 6.2kΩ resistors to 4.7kΩ each.

Initial surge current may overload generator

I purchased an 'el cheapo' 4.5kVA generator to replace my old Honda EU20i. The Honda could handle my inverter welder for short bursts but it was being pushed past its limits.

The problem is as soon as I attempt to strike an arc, the el cheapo unit drops dead! We're talking milliseconds here! There's not even time to generate a spark. There are no alarm lights – just dead.

Now before the masses start telling

MARKET CENTRE

Cash in your surplus gear. Advertise it here in SILICON CHIP

FOR SALE

PCB MANUFACTURE: single to multi-layer. Bare board tested. One-offs to any quantity. 48 hour service. Artwork design. Excellent prices. Check out our specials: **www.ldelectronics.com.au**

Audio + Video: Professional quality Quest AV brand equipment is made and sold in Australia exclusively by Quest Electronics. Ph 0431 920 667. **sales@questronix.com.au**

DIRECT FROM CHINA: Kinsten PCB, high-speed drill press, hookup wire. A$ prices **www.kinsten.co**; USD prices **http://www.aliexpress.com/store/130218** Low prices include postage.

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics Phone 0434 781 191. **sesame@sesame.com.au** **www.sesame.com.au**

Superbright LEDs of all sizes, shapes and colours, brand names like Cree and Avago as well as low cost generic LEDs for non-critical applications. Also stocking kits, components and other assorted items. If we don't have it, just ask, we can order almost anything in! LEDsales, **www.ledsales.com.au**

PCBs & Micros: Silicon Chip Publications can supply PCBs and programmed microcontrollers for all recent projects. Order online or phone (02) 9939 3295.

KIT ASSEMBLY & REPAIR

RF REPAIRS - Australia wide repair service of most two way radio equipment. Please contact us on (02) 4305 2301 or **service@rfrepairs.com.au**

VINTAGE RADIO REPAIRS: electrical mechanical fitter with 36 years experience and extensive knowledge of valve and transistor radios. Professional and reliable repairs. All workmanship guaranteed. $10 inspection fee plus charges for parts and labour as required. Labour fees $35 p/h. Pensioner discounts available on application. Contact Alan on 0425 122 415 or email **bigalradioshack@gmail.com**

KEITH RIPPON KIT ASSEMBLY & REPAIR:
* Australia & New Zealand;
* Small production runs.

Phone Keith 0409 662 794. **keith.rippon@gmail.com**

SERVICES

CONSULTING AND ENGINEERING SERVICES Pty Ltd specialises in the design and manufacture of electronic based products. We do volume manufacturing and reverse engineering. Contact 0247323310 or email **nbsethna@gmail.com** to discuss your requirements

ADVERTISING IN MARKET CENTRE

Classified Ad Rates: $32.00 for up to 20 words plus 95 cents for each additional word. Display ads in Market Centre (minimum 2cm deep, maximum 10cm deep): $82.50 per column centimetre per insertion. All prices include GST.
Closing date: 5 weeks prior to month of sale. To book, email the text to **silicon@siliconchip.com.au** and include your name, address & credit card details, or phone Glyn (02) 9939 3295 or 0431 792 293.

me about loading and kW vs kVA etc, the el cheapo runs air-conditioning that the Honda could never do without hesitation. It will run all the power tools I have without fault. So what's in the circuitry that freaks out with an inverter welder attached? Is there a way around it? (P. L., via email).

● It could be due to the instantaneous surge current into the large input capacitor in the inverter welder. One possible way to stop that would be to use our SoftStarter for Power Tools, published in the July 2012 issue. You can see a 1-page preview of the article at **www.siliconchip.com.au/Issue/2012/July/Soft+Starter+For+Power+Tools**

If you are interested, you can purchase the issue and buy the PCB on the website: **www.siliconchip.com.au/Shop/8/665**

Question on PICkit3 programmer

I am hoping you may be able to help with a problem I have just encountered with the Micromite/GPS clock project from the May 2014 magazine. After using my PICkit3 for a number of years with Windows XP, I have just upgraded my desktop computer to Windows

continued next page

RFMA RF Modules Australia
Low Power Wireless Connectivity Specialists

USB BLUETOOTH
PARANI UD100-G03
Class 1 Bluetooth 2.0+EDR
Working distance to 300m
BlueSoleil Bluetooth Stack
Optional 5dBi Dipole Antenna

Applications:
Rural
Utilities
Industrial
Commercial
Government
Meter Reading

ORDER ONLINE NOW @ www.rfmodules.com.au

RF Modules Australia. P.O. Box 1957 Launceston, TAS., 7250.
Ph: 03-6331-6789. Email: sales@rfmodules.com.au. Web: rfmodules.com.au

Ask SILICON CHIP
. . . continued from page 103

7 Ultimate 64-bit and my laptop to Windows 7 Pro 32-bit.

I find that my PICkit3 no longer works with these operating systems. Have you heard of this problem or know of a solution? I cannot program my Maximite chip which is frustrating. I do have a PICkit2 which will work with the Windows 7 programs but the PIC32MX150F128B-50I/SP is not a supported chip.

I have emailed Microchip directly but received no reply after a couple of weeks and I have searched the internet and forums but cannot seem to find a solution. I have also tried running MPLAB IDE and the standalone PICkit3 programmer under the Windows XP emulation mode of Windows 7 to no avail. (P. C., via email).

● In our experience, the PICkit3 does work with Windows 7 Ultimate 64 bit. Our suggestion is to uninstall MPLAB X (if you have it installed), then install the latest version from the Microchip website. Make sure that you follow the instructions regarding the installation of drivers, then open up MPLAB IPE. It is an independent programmer installed with MPLAB X and it knows how to use the PICkit3 to program the PIC32MX150.

Notes & Errata

100W Hybrid Switchmode/Linear Bench Supply, Pt.3, June 2014: the statement "with the pot fully anti-clockwise, there should be minimum resistance between the left-most and centre pins on CON5 & CON6" is for the pins as viewed from the front of the unit (ie, opposite to the orientation of the PCB overlay diagram).

DOWNLOAD OUR CATALOG AT
www.iinet.net.au/~worcom
WORLDWIDE ELECTRONIC COMPONENTS
PO Box 631, Hillarys, WA 6923
Ph: (08) 9307 7305 Fax: (08) 9307 7309
Email: worcom@iinet.net.au

Capacitor discharge ignition for a go-kart

We race go-karts with Yamaha 100J engines. As with most 2-strokes, they are fitted with a magneto-style ignition. This is fitted with what Yamaha call a 'Charge Coil' and a 'Pulser Coil', where the output cables go to an ignition box with the plug wire coming out.

This is where the problem starts – Yamaha give a test reading for the HT circuit of 10Ω. I have four boxes, two of which read OK while the other two read 3.8Ω and give a weak spark.

As these boxes are sealed with a type of resin, you are unable to see inside. The boxes are now unavailable so I would like to know if they could be repaired once inside or could a new set-up be made and put inside the box.

I realise that this is a long shot. Yes, secondhand ones do come on the market but it is a gamble as to their condition. (L. C., Wilton, NSW).

● We published a replacement CDI Module for Motorbikes/Small Petrol Motors in May 2008. This required a charge coil and trigger/pulser coil as in your Yamaha engine.

You would need to add an ignition coil to the circuit as the CDI module does not have that but is designed to connect to one. Almost any standard 12V ignition coil should be suitable although those for motorcycles tend to be smaller than automotive types.

You can view a preview of the article at **www.siliconchip.com.au/Issue/2008/May/Replacement+CDI+Module+For+Small+Petrol+Motors**

You can purchase the full issue and the PCB at **www.siliconchip.com.au/Shop/** SC

Advertising Index

Altronics	78-81
Australian Exhibitions & Events	5
Emona Instruments	4
Front Panel Express	39
Gless Audio	103
Hare & Forbes	OBC
Icom Australia	59
Jaycar	IFC,49-56
KCS Trade Pty Ltd	9
Keith Rippon	103
Kinsten Pty Lrd	103
KitStop	39
LD Electronics	103
LEDsales	103
Master Instruments	103
Microchip Technology	7
Mikroelektronika	IBC
Ocean Controls	25
QualiEco Circuits Pty Ltd	45
Quest Electronics	103
Radio & Hobbies DVD	69
RFrepairs	103
RF Modules	104
Rohde & Schwarz	3
Sesame Electronics	103
Silicon Chip Binders	35,97
Silicon Chip Online Shop	90-91
Silicon Chip Subscriptions	47
Silvertone Electronics	13
Wiltronics	11
Worldwide Elect. Components	104

TURN TALK TO ACTION

Standard switches are OK, but in certain situations
you need a more satisfying solution. Control your home
with your voice. Try **SpeakUp** the speech recognition click board.

price:
$39^{00}

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS

GET IT NOW
www.mikroe.com/click/speakup/

ENGINEERING
WORKSHOP EQUIPMENT

High Speed Steel Bits
- High speed steel 5% cobalt
- 5/16" SQ x 2 1/2" long (L001B)
- 1/2" SQ x 4" long (L005B)
- 16 x 4 x 100mm (L0114)

~~$2.85~~ **$2** (L001B)
~~$13.20~~ **$8** (L005B)
~~$28.60~~ **$19** (L0114)

Universal Deburring Tool Set
- 4 x screw on flute countersinks
- 1 x deburring tool
- 1 x HSS blade
- 1 x pocket clip deburring tool

~~$49.50~~ **$33** (D062)

32-193 Vernier Calipers
- 0-150mm/6" range
- ±0.03mm accuracy

~~$75.90~~ **$44** (Q193)

METRIC & IMPERIAL

34-2191 Digital Test Indicator
- ±0.5mm / ±0.02" range
- 0.003mm graduations
- Metric/Imperial with data interface
- Zero setting at any position

~~$198.00~~ **$99** (Q2191)

10 piece Screw Extractor Set
- Thread extractor range 3/16" - 5/8" (M5-M16)
- 1/8", 5/32", 3/16", 7/32", 1/4", 9/32", 5/16", 11/32", 3/8", 13/32"

~~$26.40~~ **$22** (T870)

Re-Threading Tap & Die Kit Metric, UNC, UNF
- Metric (M6 M12)
- UNC & UNF (1/4"-5/8)
- Fine & coarse threads

~~$99.00~~ **$88** (T020)

11-1001 Ezy Read Digit Micrometer
- 0-1" range
- 0.004mm accuracy

~~$88.00~~ **$60** (Q1001)

IMPERIAL

Screw Thread Micrometers
- V-shaped and cone-shaped anvils
- Ratchet friction thimble
- Resolution: 0.01mm/0.0001"
- 5 x 550 anvils
- Measures 3.5 - 18TPI

10-1371 1-2" range ~~$148.50~~ **$90** (Q1371)
10-1372 2-3" range ~~$203.50~~ **$90** (Q1372)
10-1373 3-4" range ~~$218.90~~ **$90** (Q1373)

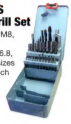
Metric Thread Repair Kit
- Metric M5 x 0.8mm M6 x 1.0mm M8 x 1.25mm M10 x 1.5mm M12 x 1.75mm

~~$163.90~~ **$149** (T100)

130 PIECES

29 Piece - HSS Hand Tap & Drill Set
- M3, M4, M5, M6, M8, M10, M12
- 2.5, 3.3, 4.2, 5.0, 6.8, 8.5,10.2mm drill sizes
- Includes tap wrench

~~$76.90~~ **$66** (T019)

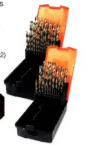


Precision Jobber Drill Sets
- Precision ground flutes
- HSS M2 bright finish

25 Piece Metric (D1272)
- Range: 1-13mm
- 0.5mm increments

29 Piece Imperial (D1282)
- Range: 1/16 - 1/2"
- 1/64" increments

~~$88.00~~ **$79** (D1272)
~~$90.20~~ **$79** (D1282)



EDBD-13 Drill Sharpener
- 3-13mm or 1/8"-1/2"
- Split point
- 80W, 240V motor

DIAMOND WHEEL

~~$99.00~~ **$89** (D070)

PTB-18C Parts Bin
- 550 x 400 x 880mm
- 20kg load per bin
- Clear window to identify parts
- Includes 18 bins & 36 dividers

~~$473.00~~ **$375** (T7961)

ITEMS SOLD SEPARATELY

RST-300H Platform Trolley
- 300kg load capacity
- 952 x 608mm platform
- 2 fixed & 2 swivel wheels
- 152mm rubber wheels

~~$176.00~~ **$129** (T674)

AL-30 (SIEG C2) Mini Bench Lathe
- 180 x 300mm turning capacity
- 20mm bore, 80mm 3 jaw chuck
- Electronic variable speed
- 0.25kW, 240V motor

20mm BORE

~~$825.00~~ **$749** (L194)

HM-10L (SIEG X2L) Mini Mill Drill - Tilting Head
- Dovetail column
- 2 speed gearbox
- Head tilts ±45°
- 350W 240V motor
- Travels: (X) 310mm (Y) 130mm (Z) 190mm

~~$946.00~~ **$895** (M150A)

BECOME A MACHINERYHOUSE MATE

GAIN ACCESS TO:
- ONLINE PROMOS
- EXCLUSIVE OFFERS
- TRACK YOUR ORDERS
- CLICK & COLLECT
- PAPERLESS WARRANTY
- NEWSLETTERS
- LATEST RELEASES
- COMPETITIONS

$50 MATES' BATH + $20 MATES' 50 = $70 FREE DISCOUNT VOUCHERS

SIGN UP FOR MATES RATES
MACHINERYHOUSE.COM.AU/SIGNUP

PROMO CODE
CIRCUITS
Use promo code ONLINE OR INSTORE! To receive these special offers Valid until 30-07-14

Note: Discount vouchers are valid for online purchases only

Specifications & Prices are subject to change without notification. All prices include GST and valid until 30-07-14

HARE&FORBES MACHINERYHOUSE

NSW	QLD	VIC	WA
(02) 9890 9111	(07) 3274 4222	(03) 9212 4422	(08) 9373 9999
1/2 Windsor Rd, Northmead	625 Boundary Rd, Coopers Plains	1 Fowler Rd, Dandenong	41-43 Abernethy Rd, Belmont

www.machineryhouse.com.au

07-JC-26814